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Predator-prey Relations and Breeding Biology of the Great Horned Owl and Red-tailed Hawk in Central Alberta

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Abstract. Breeding-season populations of Great Horned Owls near Rochester, Alberta, exhibited marked functional (dietary) and numerical responses to a cyclic increase of snowshoe hares during 1966-1971. The Red-tailed Hawk population responded functionally, but not numerically, to the growing hare population. This functional response by both raptors was largely responsible for a "buffering" of predation on Ruffed Grouse and probably other prey species. As hare densities increased, the percent biomass of grouse in the raptor diet declined, as did rates of predation on the grouse population. Rates of horned owl predation were similar on low and peak hare populations; but rates of predation by red-tails were lowest on peak hare populations. The annual distribution of nesting horned owls and red-tails tended significantly toward regularity, and nest distribution relative to major cover-types was remarkably constant from year to year. It was concluded that the regular distribution of nests reflected territoriality, which spaced (intra- and inter-specifically) active nests and also limited red-tail but not horned owl densities. Food habits of individual horned owl and red-tail pairs were predictably related each year to the proportion of various cover-types surrounding their nests when such cover comprised habitat for snowshoe hares, meadow voles, Richardson's ground squirrels, or waterfowl.

Introduction

This paper examines populations of Great Horned Owls (*Bubo virginianus*) and Red-tailed Hawks (*Buteo jamaicensis*) near Rochester, in central Alberta. It describes major elements of their demography (numbers, distribution, reproduction), interspecific relationship, and food habits. It also attempts to estimate rates of predation on three prey species, and to measure the effects of changing prey density and cover-type on predator-prey interactions.

Rusch et al. (1972) reported that food habits and breeding densities of horned owls at Rochester were strongly influenced by a cyclic increase in the snowshoe hare population. But Luttich et al. (1970, 1971) described the red-tail population on the same study area as being little affected by prey fluctuations. Craighead and Craighead (1956, p.227), working in Michigan and Wyoming, concluded that raptor numbers tend to be stationary from one breeding season to the next, with densities (but not food habits) generally unaffected by changes in prey abundance. In the Arctic, however, raptor populations exhibit strong numerical and functional responses to changes in their limited and highly unstable prey base (Nicholson 1930; Pitelka et al. 1955a, b).

Methods

The study area and methodology employed in this investigation have been described by Rusch et al. (1972) and Luttich et al. (1970, 1971), and will be only briefly re-outlined here.

Study Area

The 62.5-square-mile study area, expanded from 50 square miles in 1967, is located in central Alberta near Rochester, about 60 miles north of Edmonton. Cover is 44% agricultural, 34% forest, 11% brush, 9% bog-meadow, and 2% aquatic (Table 1). The area is approximately 80% upland, 55% of which is under cultivation. The remainder consists largely of

TABLE 1. — Cover-types and composition of the 62.5-square-mile study area

Cover-types	Area: Square miles	Area: Percentage
Agriculture: all land in cultivation, pastures, and forest clearing	27.5	44
Forest: all wooded habitat including that partially burned in the fire of 1968	21.3	34
Brush: wooded areas completely burned over; all shrub-dominated habitat	6.9	11
Bog-meadow: low wet areas dominated by sedges, usually associated with forest stands	5.6	9
Aquatic: marshes with cattails, bulrush and/or large sedges; open water	1.3	2

forest dominated by aspen (*Populus tremuloides*) and balsam poplar (*P. balsamifera*). Lowlands are of two main types: cattail (*Typha latifolia*) and bulrush (*Scirpus* spp.) marshes; and black spruce (*Picea mariana*) and tamarack (*Larix laricina*) bogs.

Prey Populations

Snowshoe hare (*Lepus americanus*) populations within the study area have been continually monitored since 1961. Detailed descriptions of the areas censused, methods used, and hare demography have been published by Meslow and Keith (1968), and Keith et al. (1968). The total hare population on the raptor study area was estimated each year from spring and summer densities on five smaller hare study areas. In this extrapolation, all forest and brush was considered hare habitat.

Ruffed Grouse (*Bonasa umbellus*) populations in the Rochester area have been monitored on four sites since 1966 (Rusch and Keith 1971; Keith, unpublished). In estimating the total Ruffed Grouse population, we expanded these smaller study-area data to include all forested habitat.

Annual indices to Sharp-tailed Grouse (*Pedioecetes phasianellus*) populations were a count of the maximum number of males on a dancing ground near Rochester each April, and November-March counts from a helicopter during censuses of a coyote (*Canis latrans*) study area (70 square miles) lying about half within the raptor study area.

During late August and early September each year, two lines each of 50 snap-traps, set at approximately 50-foot intervals, were run for 10 consecutive days (giving a total of 1,000 trap days) to index mouse and vole populations. These traplines sampled about equal amounts of forest, brush, bog-meadow, and aquatic habitat. No traps have been consistently placed in agricultural habitat because our early interests were in population fluctuations in natural cover-types; thus the abundance of *Microtus* relative to *Clethrionomys* and *Peromyscus* is markedly under-represented in our sample.

Richardson's ground squirrel (*Spermophilus richardsonii*) population indices have been calculated from numbers of adults emerging in early spring on three to five pastures near Rochester. These data are our most reliable indicators of yearly population fluctuations (Dorrance and Keith, unpublished). But because we did not have the time to determine ground-squirrel densities in other agricultural habitat (where they are largely transitory), it was impossible to compute meaningful estimates of total numbers on the entire raptor study area.

Raptor Population Census

Each year the raptor study area has contained approximately 100-130 large nests that could have been used by breeding owls or hawks. Nests were checked in late March for incubating Great Horned Owls, and again in late April for Red-tailed Hawk occupancy. Nest-trees were climbed only after the mean hatching dates of 25 April for horned owls and 5 June for red-tails, to avoid nest desertion (Luttich et al. 1971). Horned owls and red-tails which we knew to be residents of the raptor study area as a result of our hooting counts (Baumgartner 1939) and/or repeated observations, but which did not attempt to nest, were considered non-breeders. Yearling red-tails (non-red-tailed birds) were present on the area and one was known to have nested. The non-nesting members of the yearling cohort are probably quite mobile and certainly less conspicuous than territorial pairs; exact counts of their numbers proved difficult.

Tethering of Young Raptors

Young owls and hawks were tethered (Errington 1932) at age 3-4 weeks, near the base of the nest tree. Thereafter tethering sites were visited every other day for 4 to 5 weeks to collect regurgitated food pellets and to note prey remains.

To protect newly-tethered red-tails from soaking rains and subsequent chilling, we suspended 3-foot-square sheets of polyethylene 2 feet above each tethering site for about a week, or until the young had regained the weight loss that is characteristic of the first few days of tethering. These sheets apparently did not interfere with feeding by the adults, at the same time markedly reducing early losses from exposure.

In 1968 and 1971, 15 and 10 active red-tail nests off the Rochester study area were monitored throughout the breeding season to obtain additional data on clutch size, hatching success, and nestling survival.

In 1968, 20% of the young off the study area (no tethering) were lost from weather-induced mortality or disappeared before fledging; this compared with a 44% loss on the study area (all tethered), most of which was believed due to horned owl predation (see section on *Raptor Numbers and Reproduction*). In 1971, mortality due chiefly to severe weather was 41% off the study area; mortality on the study area where protective sheets of polyethylene were used was only 11%. Thus, when properly protected from adverse weather during the initial stages, tethering of red-tail young did not increase rates of loss to natural mortality factors.

In 1971 survival of 13 untethered and 22 tethered horned owl young during the 4- to 5-week tethering period was 100%.

Nest Distribution

Breeding-season territoriality of birds of prey is well known (Baumgartner 1939; Craighead and Craighead 1956, p.256; Murphy et al. 1969; etc.). In some raptorial species, territoriality may be a spacing mechanism that distributes individual pairs without relation to available food supplies (Ratcliffe 1962; Brown and Watson 1964). Even in arctic raptors, which often concentrate in areas of temporary prey abundance, territoriality is still apparent (Nicholson 1930; Pitelka et al. 1955 a, b). We tested the nature of spacing within and between nesting Great Horned Owl and Red-tailed Hawk populations using a "nearest-neighbor test" of dispersion (Clark and Evans 1954). Mean distances from one active nest to the next nearest in any direction were compared to the expected mean distance under a random distribution. We hypothesized that significant regularity in spacing would be a logical outcome of territoriality among resident pairs.

Raptor Food Habits

Information on food habits of horned owls and red-tails came mainly from pellets and prey remains collected at tethering sites (Luttich et al. 1970; Rusch et al. 1972). But in 1966 about half of the horned-owl pellet sample was collected at spring roosting sites. Techniques used to identify prey from pellet remains, and the biases that occur in enumeration have been previously discussed (Errington 1932; Luttich et al. 1970; Rusch et al. 1972). Prey were identified from teeth, bones, hair, feathers, etc. We followed the guidelines of Fitch et al. (1946) and credited only one individual of a species to any one pellet, unless numbers of teeth and bones indicated otherwise. This approach probably tends to underestimate the actual number of individual prey consumed.

Predation Rates

To assess raptor predation rates we had to have the following information: (1) the number of "raptor-days" on the area (i.e., the number of birds times their period of residence), (2) composition of the raptor diet, (3) prey-species abundance, (4) average weights of the different prey species, and (5) the quantitative food requirements of the raptors. We selected specific time periods for estimating rates of predation, viz. 91 days from 1 April through 30 June for horned owls, and 131 days from 15 April through 31 August for red-tails. Data from Howard (1958), Fitch et al. (1946), and Craighead and Craighead (1956, p. 412) were used to estimate a daily food requirement of 144 grams per day for adult and juvenile (post-fledging) owls and 140 grams per day for adult and juvenile red-tails. The prey biomass killed daily for nestling raptors (pre-fledging) was determined directly from collections at tethering sites.

The total biomass of prey killed was viewed in two ways. First, biomass killed was assumed equal to biomass consumed; second, biomass killed was considered greater than biomass consumed owing to wastage. Individual prey which were heavier than the estimated maximum daily rations of 310 grams for horned owls and 232 grams for red-tails (Howard 1958; Craighead and Craighead 1956, p.412) were considered not to have been completely consumed. The formula for estimating prey biomass killed where wastage occurs was outlined by Rusch et al. (1972).

For any one prey species, the total biomass killed by the raptor population was estimated from the product of percent biomass of that species in the raptors' diet times the estimated total biomass of all prey killed. Then, dividing average prey weight into total biomass killed gave the number of individuals of a particular species killed. Predation rate was the number killed as a percentage of the total population.

Results and Conclusions

Prey Populations

Numbers of snowshoe hares, Ruffed Grouse, and Sharp-tailed Grouse near Rochester increased substantially after 1965-1967 (Table 2). Spring hare densities rose from 16 to 306 per 100 acres of habitat by 1971 (Keith, unpublished). Densities of Ruffed Grouse per 100 acres of habitat increased from 15 in spring 1966 to 24 in 1968, declined to 16 in 1969, and rose to 22-21 during 1970-1971. Trapper-questionnaire data indicated a general province-wide increase in grouse from 1966 to a peak in 1970 (Keith, unpublished). Numbers of Sharp-tailed Grouse were highest in 1970, but declined dramatically in 1971. Indices of small mammal populations suggest largely irregular and asynchronous fluctuations during 1966-1971, with highs among *Microtus* and *Clethrionomys* in 1967 and 1969, and a notable low in *Peromyscus* during 1966-1967; annual changes were least among *Sorex*. Richardson's ground squirrel numbers increased between 1968 and 1970.

Raptor Numbers and Reproduction

GREAT HORNED OWL: Great Horned Owls increased in numbers markedly on the Rochester study area from five territorial pairs (one pair per 12.5 square miles) in 1966 to at least 16 pairs (one pair per 3.9 square miles) in 1971 (Table 3). Earlier workers have reported densities of one pair per 4.4 square mile in New York (Hager 1957), one pair per 3.0 square miles in Wyoming (Craighead and Craighead 1956, p.215), and one to three pairs per square mile in Kansas (Baumgartner 1939).

The number of pairs breeding each year rose even more sharply, from one (20%) in 1966 to 16 (100% of known pairs) in 1971. Rusch et al. (1972) believed that ingress of owls from agricultural areas south and west of Rochester was perhaps responsible for their initial increase, while local recruitment could largely have accounted for later gains, both phenomena being responses to the rapidly expanding snowshoe hare population. Pronounced movements of breeding raptors in response to fluctuating

TABLE 2. — Estimated densities and population indices of prey on the raptor study area near Rochester, Alberta, 1965–1971

Species density or index	Months	1965	1966	1967	1968	1969	1970	1971
Snowshoe hares/ 100 acres[1]	Apr–May	16	17	27	57	86	259	306
Ruffed Grouse/ 100 acres[2]	Apr–May	—	15	16	24	16	22	21
Sharp-tailed Grouse								
Dancing ground[3]	Apr–May	—	10	14	25	31	49	10
Aerial count[4]	Jan–Mar	—	1.4	1.6	1.4	1.8	2.9	0.2
Mice and shrews/ 1,000 trap-nights	Aug–Sept							
Microtus		2	9	28	1	32	7	5
Peromyscus		39	14	12	42	31	38	34
Clethrionomys		39	34	120	49	73	37	28
Sorex		26	39	26	33	23	36	18
Richardson's ground squirrels/100 acres[5]	Apr	—	—	—	205	220	400	360

[1]Mean number of adults on five study areas, except in 1969 when one area was temporarily affected by a wildfire and thus excluded.
[2]Mean number of adults on four areas during 1966–1968 and three areas during 1969–1971.
[3]Maximum number of males observed on one dancing ground near Rochester.
[4]Mean number observed per square mile during two helicopter flights covering approximately 70 square miles and overlapping about half the raptor study area.
[5]Mean number of adults on three to five study areas.

TABLE 3. — Some population statistics for the Great Horned Owl on a 62.5-square-mile area (50 square miles in 1966) near Rochester, Alberta

	1966	1967	1968	1969	1970	1971
Resident pairs	5	6	8	9	?[1]	?
Breeding (laying)	1	3	8	9	7	16
Non-breeding (non-laying)	4	3	0	0	?	?
Eggs hatched/breeding pair[2]	2.0	2.3	2.1	1.9	3.1	2.0
Percent mortality of young from hatching to fledging[3]	0	11	25	19	14	9

[1]Increased number of owls and apparent movements from winter hooting positions to spring nesting sites prevented accurate estimates of total resident pairs.
[2]These figures include some nests not on the 62.5-square-mile area: i.e., one in 1966, five in 1967, three in 1968, one in 1969, two in 1970, and six in 1971.
[3]Young dying from handling and starvation were treated as unnatural mortality and excluded from this sample because such losses did not appear among untethered birds off the study area.

prey populations are common in the far North (Bailey 1948, p.268; Pitelka et al. 1955a, b), and there is evidence of similar behavior among certain temperate-zone raptors as well (Bird 1929; Stewart 1969).

Mean clutch size among horned owls, as determined from egg counts late in incubation or from counts of nestlings plus unhatched eggs (a minimum estimate), varied little from 1966 through 1969 (Table 3, Figure 1); in 1970 clutch size increased significantly, and the mean hatching date was about 2 weeks earlier. Lockie (1955) and Mebs (1964) found that Short-eared Owls (*Asio flammeus*) and Buzzards (*Buteo buteo*) layed earlier when prey densities were high, while Houston (1971) concluded that the largest mean brood sizes among horned owls in Saskatchewan coincided with years when snowshoe hares and/or mice were noticeably more abundant. Similar increases in clutch and fledged-brood sizes of Tawny Owls (*Strix aluco*) have been correlated with increased prey populations (Southern 1959; Lack 1966, p.141). Between April 1969 and 1970 the hare population in the Rochester area increased 1.5 times to near-peak densities; and fall trapping in 1969 indicated a high *Microtus* population (Table 2). *Microtus* were still conspicuously abundant through mid-May 1970, but thereafter rapidly disappeared. We single out *Microtus* here because it comprised 78% of the total small-mammal biomass in the owl's diet.

In 1971, as in 1970, hatching dates were much earlier than during 1967-1969; but in contrast to 1970, 1971 hatching dates ranged widely (from 11 April to 8 May), and mean clutch size dropped to the 1966-1969 level (Figure 1). If horned owls had been responding solely to an abundance of hares in 1970, they would also have been expected to do so in 1971, with the hare population at its peak (Table 2). The *Microtus* population, on the other hand, had declined to scarcity by spring 1971. Had earlier hatching and larger clutches in 1970 been solely

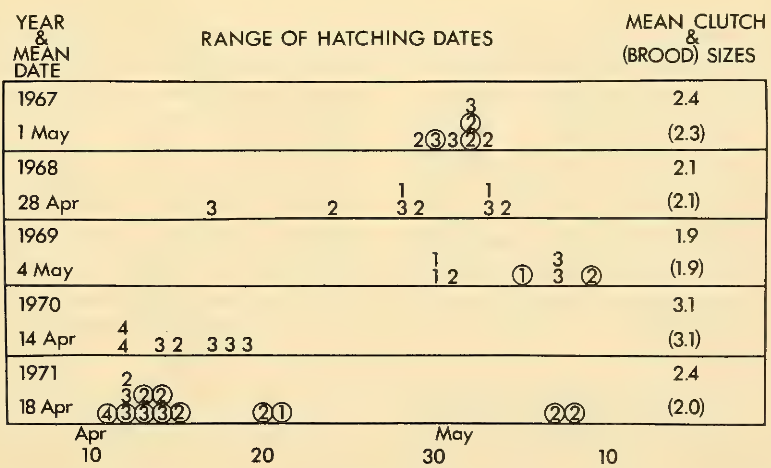

FIGURE 1. Great Horned Owl hatching dates showing clutch and brood sizes near Rochester, Alberta. Circled figures indicate nests visited in the first week after hatching or where egg counts were made. Means in parentheses include broods for which hatching dates could not be estimated.

responses to the existing high numbers of *Microtus*, then we might have expected a similar situation in 1968 following the abundance of *Microtus* in fall 1967. Unfortunately we do not know whether *Microtus* remained abundant through the spring of 1968, and food-habits data (to be discussed later) suggest that they did not (see Table 8). About all we can suggest at this time is that near-peak or peak hare populations may evoke earlier nesting, while increased clutch size may depend upon coincident high populations of both hares and voles.

Lack (1947) stated that birds laying for the first time or later in the breeding season often have smaller clutches than older or earlier-nesting individuals. He also summarized (Lack 1966, p.148) data for the Pomarine Jaeger (*Stercorarius pomarinus*) and the Spanish Imperial Eagle (*Aquila heliaca*), and hypothesized that when prey are readily available, breeding in these species occurs at a younger age (i.e., among birds with sub-adult plumage). Although our sample sizes are small, there seems little doubt that two of the 13 pairs of horned owls for which we have hatching data in 1971 were extremely late nesters (Figure 1). Note too that later clutches tended to be smaller in 1971, and that only one young was fledged from the seven eggs in the four latest nests. Perhaps one or all three of these factors indicates breeding by yearlings, which are not normally thought to be reproductively active. If yearling owls did attempt to nest in 1971, they likely did so in response to the high snowshoe hare populations.

RED-TAILED HAWK: The total red-tail population at Rochester ranged from 53 in spring 1967 to 42 in 1969 and 1971, and resident pairs varied from at least 24 in 1966 to 20 in 1971 (Table 4). The mean density of one pair per 2.9 square miles was close to that reported from the northern United States (Orians and Kuhlman 1956; Craighead and Craighead 1956, p.214; Hager 1957).

Numbers of breeding pairs have been remarkably stable, ranging only between 18 and 20 during 1967-1971. Non-breeding pairs, and single adults and yearlings comprised the most variable cohort(s) of the population.

With the exception of 1970, neither mean clutch size (2.1) nor early brood size (2.0) differed significantly between years (Table 4, Figure 2). In 1970 clutch size averaged 2.6, and 2.5 eggs hatched per nest, both figures significantly greater than in other years. The larger clutch size in 1970 paralleled that already noted for horned owls. Red-tails, however, did not nest appreciably earlier in either 1970 or 1971, nor was the hatching period extended in the latter year (Figure 2).

TABLE 4. — Some population statistics for the Red-tailed Hawk on a 62.5-square-mile area (50 square miles in 1966) near Rochester, Alberta

	1966	1967	1968	1969	1970	1971
Resident pairs	?	23	22	21	21	20
Breeding (laying)	24	20	19	18	19	19
Non-breeding (non-laying)	?	3	3	3	2	1
Resident singles	?	7	4	0	1	2
Eggs hatched/breeding pair	1.8	1.9	1.9	1.9	2.5	2.1
Percent mortality of young from hatching to fledging[1]	5	13	44 (20)[2]	34	9	11 (41)[2]

[1]Young dying from handling and starvation were treated as unnatural mortality and excluded from this sample because such losses did not appear among untethered birds off the study area.
[2]Mortality observed at 15 off-study-area nests in 1968 and 10 off-study-area nests in 1971.

A major prey of red-tails, but not of the owls, was the Richardson's ground squirrel (see Tables 8 and 9). This rodent was more abundant in 1970 and 1971 than in the two previous years (Table 2). Both raptors, of course, utilized snowshoe hares and *Microtus*. In attempting to explain the significantly larger red-tail clutches in 1970, we can again only point to the high *Microtus* population of early spring 1970.

Mortality from hatching to fledging has fluctuated greatly from year to year (Table 4). The high rates of loss in 1968 and 1969 (44 and 34%) were mainly due to horned owl predation on tethered young (Luttich et al. 1971). We suspect, but cannot prove, that juvenile owls were largely responsible, since they would have been fully fledged for 1 to 2 months and probably having to support themselves. In 1970 and 1971 there was no mortality among red-tail young that we could attribute to owls. During these last 2 years the snowshoe hare population reached a cyclic peak (Table 2), and their increased availability may have effectively buffered owl predation on the red-tails.

Distribution of Nests

The yearly distribution of active horned owl nests at Rochester was neither random nor contagious (Table 5). Calculated dispersion values for 3 of the 4 years with more than six nesting pairs (1968–1971)

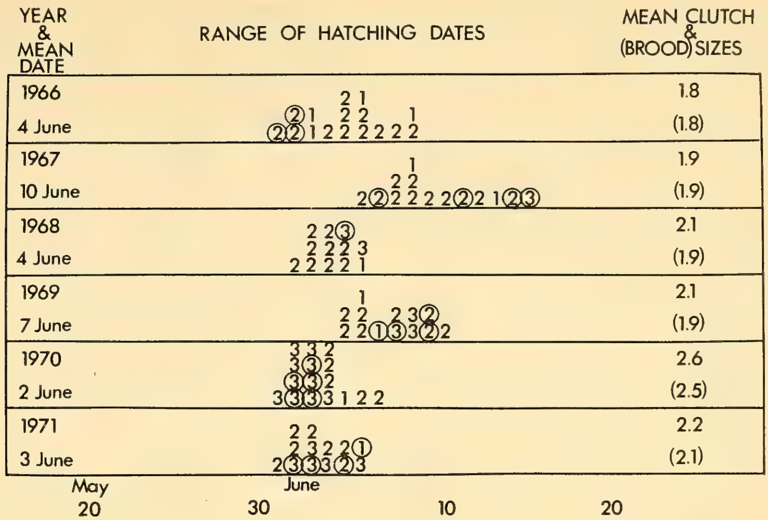

FIGURE 2. Red-tailed Hawk hatching dates showing clutch and brood sizes near Rochester, Alberta. Circled figures indicate nests visited in the first week after hatching or where egg counts were made. Means in parentheses include broods for which hatching dates could not be estimated. Estimates of hatching dates during 1966–1969 differ somewhat from those reported in Luttich et al. (1971); the latter were miscalculated.

were significantly larger than 1.0 ($P <.01$), indicating a tendency toward regular spacing of breeding pairs. This almost certainly reflects the well-known territoriality of horned owls and many other large raptors (Baumgartner 1939; Craighead and Craighead 1956, p.268; Brown and Watson 1964). Regular spacing was even more evident among nesting red-tails (Table 5), dispersion values for all years (1966–1971) being significantly larger than 1.0 ($P < .01$).

The persistent regularity of nest distribution is reflected also in the average yearly representation of major cover-types within a 0.75-mile radius of active nests (Table 6). Note that such representation is remarkably constant, and similar to that for the study area as a whole.

The mean distance between horned owl nests declined progressively from almost 2.5 miles in 1968 to 1.5 miles in 1971 (Table 5) as the breeding population increased (Table 3). Mean distance between red-tail nests fluctuated little from year to year (Table 5) with stationary breeding populations; their 1966–1971 mean of 1.3 miles suggests a defended area of approximately 0.65-mile radius if territories were circular and of equal size. Craighead and Craighead (1956, p.257) estimated an average hunting range of 0.75-mile radius. It appears that territoriality has not only spaced the red-tail pairs, but may well have limited the number of nesting pairs in the Rochester area. In contrast, territoriality has not yet limited horned owl breeding densities which in 1971 approached those of the red-tail.

To explore possible interaction between breeding horned owls and red-tails, we combined data on annual nest-site distribution. Distances between all active nests and their nearest neighbor (either owl or hawk) were compared to the expected distance in a random distribution. The resulting dispersion ratios were again significantly larger than 1.0 ($P < .01$), implying that territorial spacing may also occur between nesting owls and hawks (Table 5. See footnote[1]). We next compared nearest-neighbor distances between owl nests, owl and hawk nests, and hawk nests. The 1971 data were used because owl densities were greatest that year. After adjusting nearest-neighbor distances for each species to an arbitrary standard density of 35 pairs (the total number of nests), we found no significant differences between the mean distances of 1.3 miles (owl-to-owl), 1.2 miles (owl-to-hawk), and 1.5 miles (hawk-to-hawk). This test further suggests the existence of interaction between nesting horned owl and red-tail pairs. Note, however, that such interaction did not cause a reduction in red-tails in the study area, even though owl densities rose more than threefold.

TABLE 5. — Dispersion of nests of Red-tailed Hawks and Great Horned Owls on the 62.5-square-mile (50 square miles in 1966) study area near Rochester, Alberta[1]

Species and year	Nests	Mean distance in miles to nearest neighbor (± standard error): Observed (A)	Expected (B)	Nest dispersion ratio ($R = A/B$)[2]
Great Horned Owl				
1967	3	1.68 ± .11	1.98 ± .57	0.85
1968	8	2.40 ± .27	1.49 ± .28	1.61**
1969	9	2.16 ± .20	1.38 ± .24	1.55**
1970	7(?)[3]	1.91 ± .40	1.61 ± .32	1.14
1971	16(?)[3]	1.47 ± .12	1.02 ± .13	1.44**
Mean		1.92	1.50	1.32
Red-tailed Hawk				
1966	24	1.12 ± .09[3]	0.72 ± .08	1.55**
1967	20	1.33 ± .13	0.84 ± .09	1.58**
1968	19	1.28 ± .09	0.86 ± .10	1.48**
1969	18	1.19 ± .14	0.88 ± .10	1.35**
1970	19	1.40 ± .16	0.88 ± .10	1.58**
1971	19	1.50 ± .16	0.91 ± .11	1.65**
Mean		1.30	0.85	1.53

[1]Dispersion ratios for all active nests of both species were 1.37**, 1.36**, 1.58**, and 1.35** from 1968 to 1971.
[2]In a completely regular distribution, R = 2.15; in a completely random distribution, R = 1.0; and in a completely aggregated distribution, R = 0 (Clark and Evans 1954). Double asterisks (**) indicate significant difference from a random distribution ($P < 0.01$).
[3]Increased number of owls and apparent movements from winter hooting positions to spring nesting sites prevented accurate estimates of total resident pairs.

TABLE 6. — Composition of cover surrounding active Great Horned Owl and Red-tailed Hawk nests on the Rochester study area. All cover within a radius of .75 miles from each nest was classified and measured. Cover types are defined in Table 1.

	Year	Average percentage of different cover-types annually: Agriculture	Forest	Brush	Bog-meadow	Aquatic
Great Horned Owl nests	1967	45	36	8	10	1
	1968	41	38	10	7	1
	1969	46	32	9	11	1
	1970	33	38	15	10	4
	1971	44	33	11	7	4
Mean		42	36	11	9	2
Red-tailed Hawk nests	1966	45	28	10	9	9
	1967	38	34	14	9	6
	1968	51	29	9	8	5
	1969	40	30	14	8	3
	1970	42	35	7	10	4
	1971	49	30	10	10	2
Mean		41	34	11	10	4
Composition of entire 62.5-square-mile study area		44	34	11	9	2

An additional aspect of breeding-season interaction between these two species is the extent to which the earlier-nesting owls usurp old nests and thereby cause red-tails to build new ones. To our knowledge, only five new nests were built by red-tails during 1966–1968; during the next 3 years, 9, 10, and 10 new nests, respectively, were built (Table 7). Utilization of nests by red-tails in two successive years declined progressively from 71% in 1967 to 42% in 1971 as the number of nesting owls increased. These data suggest that there is competition between the two species for existing nests. Orians and Kuhlman (1956) reported earlier that 31 of their 48 horned owl nests were built by red-tails.

Raptor Food Habits

GREAT HORNED OWL: The snowshoe hare has been the single most staple prey of Great Horned Owls at Rochester (Table 8). Biomass of hares in the owl diet during 1966--1971 increased fourfold from 23 to 81%, while spring hare densities increased over 19-fold (Table 2). The proportion of juvenile hares in the horned owl diet increased from 0 in 1966–1968, to 14, 18, and 21% of all hares taken during 1969–1971. On the other hand, consumption

TABLE 7. — Summary of reuse of old nests in successive years, and numbers of new nests built annually by Red-tailed Hawks on the Rochester study area

Year	Percentage of pairs utilizing nests that were active during the previous year	Number of new nests built
1966	?	0[1]
1967	71	5
1968	68	0[1]
1969	53	9
1970	50	10
1971	42	10

[1]No new nests were found in 1966 and 1968.

TABLE 8. — Food habits of nestling Great Horned Owls near Rochester, Alberta. Numbers of nests during 1966–1971 were 1, 3, 7, 7, and 9, respectively[1]

	Percent frequency						Percent biomass					
Prey species[2]	1966	1967	1968	1969	1970	1971	1966	1967	1968	1969	1970	1971
Snowshoe hare	2	4	10	8	13	27	23	34	50	50	77	81
Pocket gopher	11	7	19	21	2	9	15	6	10	14	1	3
Mice and voles	68	69	54	55	80	48	18	11	6	8	12	4
Other mammals	4	3	3	1	1	2	12	7	6	1	1	1
Total mammals	85	83	86	85	96	86	68	58	72	73	90	89
Ruffed Grouse	4	2	2	0	tr[3]	tr	23	6	4	0	1	tr
Sharp-tailed Grouse	0	tr	3	1	tr	tr	0	2	10	3	tr	tr
Waterfowl	1	4	4	6	2	7	7	20	10	18	7	9
Other birds	4	10	5	8	3	5	2	14	3	6	1	2
Total birds	9	16	14	15	5	13	32	42	27	27	10	11
Totals	100	99	100	100	101	99	101	100	99	100	100	100

[1]Total numbers of food items were 114, 986, 518, 338, 756, and 775 in 1966 through 1971; biomass totals (in grams) were 12,103; 174,786; 140,027; 71,778; 193,736; and 321,489, respectively.

[2]Prey not specifically identified in the table were the following: "Mice and voles" — *Microtus pennsylvanicus* (averaged 78% of small-mammal biomass), *Peromyscus maniculatus* (20%), *Clethrionomys gapperi* (2%), *Zapus hudsonius* (trace), and *Sorex c. cinereus* (trace). "Other mammals" — *Ondatra zibethicus, Tamiasciurus hudsonicus, Spermophilus richardsonii, S. franklinii, Glaucomys sabrinus, Mustela frenata, M. rixosa, M. erminea.* "Waterfowl" — *Anas platyrhynchos, A. acuta, A. strepera, A. discors, A. carolinensis, Mareca americana, Spatula clypeata, Aythya americana, A. collaris, A. affinis, Fulica americana, Bucephala albeola, Podiceps grisegena, Porzana carolina, Rallus limicola.* "Other birds" — *Falco sparverius, Accipiter cooperii, Buteo jamaicensis, Columba livia, Perdix perdix, Pica pica, Perisoreus canadensis, Charadrius vociferus, Colaptes auratus, Dendrocopos villosus, Sphyrapicus varius, Sturnus vulgaris, Turdus migratorius, Dendroica petechia,* and unidentified songbirds and domestic chickens.

[3]Less than 0.5%.

of Ruffed Grouse, whose numbers also generally rose, decreased markedly. Sharp-tailed Grouse reached peak numbers in 1970, but accounted for only a trace of the owl's diet by that time.

Other major prey in certain years were the northern pocket gopher (*Thomomys talpoides*), small mammals (especially *Microtus*), and several species of waterfowl (Table 8). Pocket gophers constituted 15% of the total prey biomass consumed in 1966; mice and voles made up 18 and 12% in 1966 and 1970; and waterfowl averaged 20 and 18% in 1967 and 1969.

RED-TAILED HAWK: Richardson's ground squirrels were an important component of the red-tail diet in most years, varying from 23% biomass in 1965 to 42% in 1966 (Table 9). In 1965, 1970, and 1971, the biomass of snowshoe hares taken by red-tails exceeded that of ground squirrels. Highest hare populations occurred during 1970 and 1971, and the hawks seemingly responded to this abundance by increased utilization, which reached 52% in the latter year. The frequency of juvenile hares in the total hare kill showed little change during 1965–1971. In 1965, when the hare population was extremely low (Table 2), red-tails also relied on hares for a substantial portion of their diet. We suspect, but cannot show, that this was probably because of relatively low densities of such other prey species as Richardson's ground squirrels and *Microtus*.

Waterfowl were a major prey item in 1967, comprising 29% of the red-tails' diet, but declined to 6–7% by 1970–1971 (Table 9). The percent biomass of grouse and small mammals consumed was generally low during 1966–1971, but the

TABLE 9. — Food habits of nestling Red-tailed Hawks near Rochester, Alberta. Numbers of nests during 1965–1971 were 10, 16, 15, 13, 16, 17, and 13, respectively[1]

	Percent frequency							Percent biomass						
Prey species[2]	1965	1966	1967	1968	1969	1970	1971	1965	1966	1967	1968	1969	1970	1971
Richardson's ground squirrel	17	21	13	25	22	32	26	23	42	25	34	39	38	38
Snowshoe hare	5	2	4	7	6	14	21	25	8	17	24	21	46	52
Franklin's ground squirrel	1	4	5	6	4	tr[3]	3	1	5	7	7	5	1	3
Mice and voles	28	32	41	13	34	40	30	3	5	6	2	5	4	2
Other mammals	6	5	6	4	4	1	4	7	6	9	4	3	1	2
Total mammals	64	66	73	67	79	87	86	59	66	64	75	79	90	90
Waterfowl	5	8	12	11	5	4	5	9	18	29	11	11	6	7
Ruffed Grouse	3	2	1	6	3	2	1	7	2	1	5	4	3	1
Sharp-tailed Grouse	0	1	1	1	1	1	1	0	2	2	2	1	1	1
Unidentified grouse	1	1	1	0	1	0	1	3	4	2	0	2	0	0
Other birds	27	23	12	15	8	6	7	23	10	5	7	3	2	2
Total birds	36	34	26	32	21	13	14	41	34	37	25	21	11	10
Total	100	100	99	99	100	100	100	100	100	100	101	100	101	100

[1]Total numbers of food items were 210, 695, 1063, 585, 563, 879, and 545 in 1965 through 1971. Biomass totals (in grams) were 55,479; 167,208; 255,016; 199,851; 161,586; 298,860; and 215,637 in 1965 through 1971.

[2]Prey not specifically identified in the table were the following: "Mice and voles" — *Microtus pennsylvanicus* (averaged 88% of small-mammal biomass), *Peromyscus maniculatus* (2%), *Clethrionomys gapperi* (10%), *Zapus hudsonius* (trace), and *Sorex c. cinereus* (trace). "Other mammals" — *Ondatra zibethicus, Tamiasciurus hudsonicus, Thomomys talpoides, Glaucomys sabrinus, Mustela frenata, M. rixosa, M. erminea.* "Waterfowl" — *Anas platyrhynchos, A. acuta, A. strepera, A. discors, A. carolinensis, Mareca americana, Spatula clypeata, Aythya americana, A. collaris, A. affinis, Fulica americana, Bucephala albeola, Podiceps grisegena.* "Other birds" — *Falco sparverius, Accipiter cooperii, Columba livia, Perdix perdix, Pica pica, Perisoreus canadensis, Charadrius vociferus, Colaptes auratus, Dendrocopos villosus, Sphyrapicus varius, Sturnus vulgaris, Turdus migratorius, Dendroica petechia,* and unidentified songbirds and domestic chickens.

[3]Less than 0.5%.

latter's frequency of occurrence was relatively high in all years.

BOTH SPECIES: A clear trend in the diet of both raptors during 1965–1971 was a general increase in the proportion of mammalian prey (Tables 8 and 9). In 1966 the ratio of mammalian-to-avian prey biomass among horned owls was about 7:3; in 1971, the ratio reached 9:1. Among red-tails, the ratio changed from 6 : 4 in 1965 to 9 : 1 in 1971. This change reflects largely an increased utilization of snowshoe hares, with a concomitant drop in consumption of grouse and waterfowl. While increased use of hares was undoubtedly a reaction to rising hare densities (Table 2), note that consumption of grouse declined during 1966–1970 despite a general upward trend in population. This inverse relationship between grouse population size and percent biomass in the raptor diet suggests a buffering of predation on grouse by the more rapidly expanding hare population.

A buffer species was described by Darrow (1945) as "one . . .which presumably minimizes predation on a game bird or animal through serving as a major component of the diet of one or more of the latter's important predators." Errington (1938) felt that buffer species doubtless influenced the diet of Great Horned Owls. We believe buffering does affect food habits of horned owls and red-tails in the Rochester area, and that this relationship is most striking when both prey occupy the same habitat, as do Ruffed Grouse and snowshoe hares. Moreover, as the hares become extremely abundant at their cyclic peak, buffering of other prey may occur in different habitats within the same area, as for example with Sharp-tailed Grouse and waterfowl.

Dietary Biomass of Prey

The biomass of prey brought to tethered horned owls and red-tails has varied appreciably with these factors: (1) prey abundance in different years, (2) numbers of young raised to fledging, and (3) composition of the dominant cover surrounding nest sites.

GREAT HORNED OWL: From 1966 to 1969, when the hare population was building from its low in 1965 (Table 2), the average biomass of food supplied daily to each young owl rose slightly from 166 to 190 grams (Table 10). In 1970 and 1971, however, the amount increased significantly to averages of 328 and 411 grams per day. Hares were then at their peak and comprised 77 and 81% of total prey biomass killed.

The number of young to fledge in horned owl broods varied from one to four. The mean daily biomass of prey brought by the adults increased progressively with brood size from 293 grams for broods of one young to 1336 grams for broods of four (Table 11). The average prey biomass per young per day was highest (411 grams) at the hare peak in 1971 (Table 10).

Horned owls have shown no strong tendency to nest in habitat dominated by one particular cover-type (Table 6), even though pairs nesting in predominantly forested areas secured larger biomasses of prey than those nesting in predominantly agricultural areas (Table 12). This greater prey biomass was due to more frequent utilization of hares by owls occupying forest-oriented nests.

RED-TAILED HAWK: The average biomass of prey supplied to both red-tail broods and individual young was, as with horned owls, greatest during 1970 and 1971 (Table 10), when hares were highest in numbers and comprised about 50% of the red-tails' diet.

Redtail broods ranged from one to three young, with a sharp increase (73%) in food brought to

TABLE 10. —Prey biomass (grams) brought to tethered young

Species	1966	1967	1968	1969	1970	1971
	Average prey biomass killed per day per brood					
Great Horned Owl	—	371	349	321	953	856
Red-tailed Hawk	540	601	580	730	800	900
	Average prey biomass killed per day per nestling					
Great Horned Owl	—	166	169	190	328	411
Red-tailed Hawk	340	400	470	440	570	560

TABLE 11. — Relationship between brood size and average biomass (grams) of prey brought daily to tethering sites

Species	Brood size 1	2	3	4[1]
Great Horned Owl	293	402	860	1336
Red-tailed Hawk	410	710	730	—

[1]Two broods only, other brood-size classes include at least 10 broods each.

TABLE 12. — Average daily biomass (grams) of prey brought to tethered broods, in relation to predominant cover-types surrounding nest sites

	Predominant cover-type[1]	
	Agriculture	Forest
Great Horned Owl	466	589
Red-tailed Hawk	703	620

[1]>50% representation with a .75-mile radius of nest. Cover-types are defined in Table 1.

broods of two *vs.* one young (Table 11); the biomass of prey brought to broods of three increased only slightly over those with two young.

In contrast to horned owls, red-tail pairs nesting in predominantly agricultural areas obtained a greater average biomass of food for their young than pairs using forest-oriented nests (Table 12). The difference here was due mainly to a much higher kill of Richardson's ground squirrels on agricultural land.

Effect of Cover around Nest-sites on Raptor Food Habits

Rusch et al. (1972) concluded that at Rochester horned owl food habits during April–June were importantly affected by nest-site location. They obtained significant correlations between percent biomass of different groups of prey species in the owl diet and the percent of various cover-types within an arbitrary 0.75-mile radius (see below) of nest-sites. Rusch et al. (1972) classified both prey and cover-types as forest, open, and wetland. Luttich et al. (1970) used the same classification in examining relationships between cover and food habits of breeding red-tails, which they concluded tended to obtain food from the dominant cover surrounding nests rather than to exploit consistently one particular cover-type.

We intensified and extended Rusch's analysis of food-cover relationships by regressing, for several prey species individually, percent biomass (Y) in the horned owl and red-tail diet against percent representation (X) of each of five major cover-types within 0.75 miles of nesting sites. We continued to use this 0.75-mile radius because, as noted earlier under *Distribution of Nests,* it was still our best approximation of the hunting ranges of these raptors. Coefficients of determination (r^2) were obtained to estimate the proportion of total variance in food habits of nesting pairs attributable to differences in cover composition.[1] We were especially concerned with separating year-to-year changes in food habits caused by changing nest distribution (and hence perhaps cover-type representation) from changes in food habits caused by functional responses to changing prey density.

The five cover-types used in this regression analysis are described in Table 1. They relate to the three employed by Rusch et al. (1972) as follows: "open" cover-type was subdivided into agricultural and brush, "wetland" into bog-meadow and aquatic, and "forest" was unchanged.

Consistent positive regression coefficients indicate that utilization of a particular prey tends annually to be a direct function of the abundance of a particular cover-type around nest sites. Consistent negative regressions might arise in two ways: (1) strong positive regression coefficients with some cover-types may force negative coefficients with others; (2) decreased vulnerablity of a prey species in certain cover-types may effect decreased predation and hence negative regressions.

In cases where these coefficients are neither consistently positive nor negative there is no predictable relationship between cover around nest sites and occurrence of a particular prey species in the raptor diet.

GREAT HORNED OWL: Utilization of snowshoe hares by horned owls tended to be a direct function of the percentage of forest and brush cover surrounding their nests. This relationship was strongest (r^2 = 0.83) in 1971, when the hare population (Table 2) was at its peak.

Consumption of *Microtus*, which comprised 78% of the small-mammal biomass taken by horned owls, was positively related to the proportion of total agricultural and bog-meadow cover. In 5 out of 6 years, there was a negative relationship between *Microtus* consumption and the proportion of brushy habitat.

No consistent relationships emerged between utilization of pocket gophers and waterfowl by horned owls, and any one or combination of cover-types near nests.

RED-TAILED HAWK: The percent biomass of Richardson's ground squirrels in the red-tail diet

[1]Plots of these regression lines together with equations and coefficients of determination are available, at a nominal charge, from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2.

was in direct relation to the percentage of agricultural cover-type present; this association was strongest ($r^2 = 0.56$) in 1970, when ground squirrel populations (Table 2) were highest.

Consumption of snowshoe hares by red-tails, as by horned owls, was directly related to the proportion of forest and brush cover around nests, with r^2 values lying between .52 and .61 in 4 of 6 years. Waterfowl consumption increased with agricultural and aquatic cover-types, r^2 value averaging .70 in 1967 and 1971.

There was no consistent relationship between percent biomass of pocket gophers, waterfowl, or *Microtus* in the red-tail diet and any single or combination of cover-types.

BOTH SPECIES: The predictable association between cover-type occurrence within the likely hunting ranges of Great Horned Owls and Red-tailed Hawks and prey-species representation in their diets fully supports the conclusions of Luttich et al. (1970) and Rusch et al. (1972). Our analyses clearly illustrate the marked impact of differences in cover-type on food habits of raptor pairs during any one breeding season. Major year-to-year changes in nest distribution on the study area in relation to cover-types could thus affect attempted correlations between annual prey-density fluctuations, raptor food habits, and predation rates. As noted previously, however, territoriality tended to create a regular spacing of active nests (Table 5), with little overall change in surrounding cover each year (Table 6).

Effect of Prey Population Fluctuations on Raptor Diets

The snowshoe hare was the one major prey species of both raptors for which excellent population estimates spanned the study period. *Microtus* trapping indices were much less satisfactory because they reflected numbers in late summer; these indices probably gave a better picture of early- and mid-summer vole populations taken by red-tails than of either the previous or succeeding spring populations taken by horned owls. Census data for the Richardson's ground squirrel, an important prey of red-tails, covered only the last 4 years; and we had no meaningful information on annual changes in waterfowl.

The cyclic increase in snowshoe hares was accompanied by increased utilization in the diets of both horned owls and red-tails (Figure 3A, B). Coefficients of determination (r^2) were .71 and .88

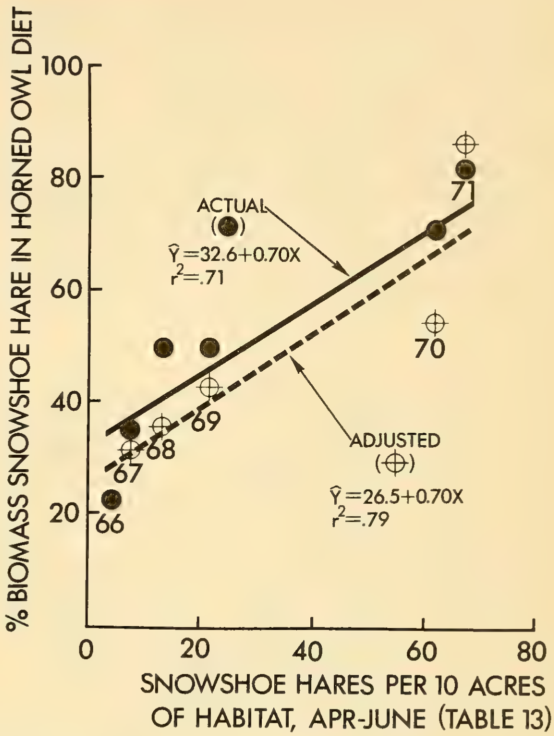

FIGURE 3A. April–June snowshoe hare densities versus actual and adjusted percent biomass of hares in the diet of Great Horned Owls near Rochester, Alberta.

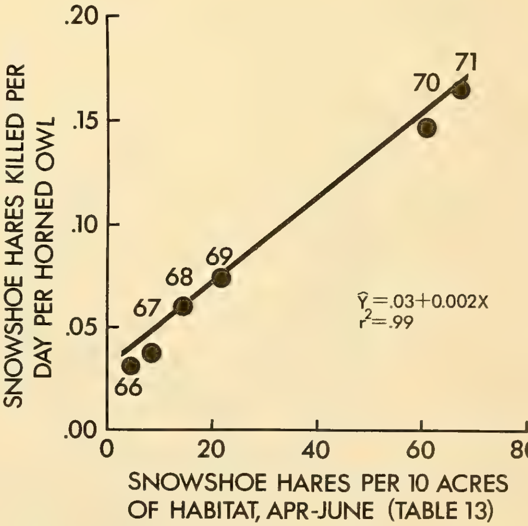

FIGURE 4A. Functional response of Great Horned Owls to changing snowshoe hare densities (April–June) near Rochester, Alberta.

for owls and red-tails respectively, using data unadjusted for annual differences in cover composition around nesting sites. Such differences were, of course, relatively minor (see Table 6), but when taken into account by adjusting percent biomass of hares in the raptor diet each year to a standard 50% forest-and brush-cover-type situation, r^2values rose even higher to .79 and .94. The strong functional response (Solomon 1949; Holling 1959) implied here is clearly seen when the mean daily hare kill is plotted against hare population density (Figure 4A, B). This kill rate increased about fivefold during 1966–1971 while snowshoe densities increased 15- to 20-fold (Table 13).

Fluctuations in *Microtus* numbers were reflected in red-tail but not horned owl food habits (Figure 6A). We suspect that this apparent lack of response by horned owls demonstrates the inappropriate timing of our late-summer vole population index, as indicated above, rather than an inherent difference

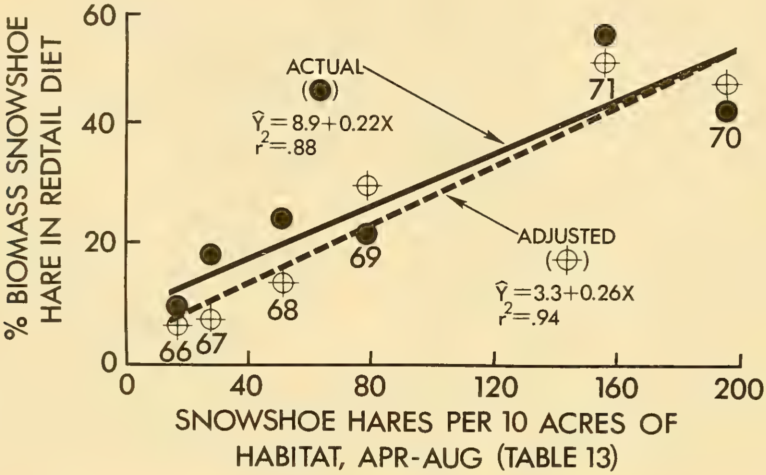

FIGURE 3B. April–August snowshoe hare densities versus actual and adjusted percent biomass of hares in the diet of Red-tailed Hawks near Rochester, Alberta.

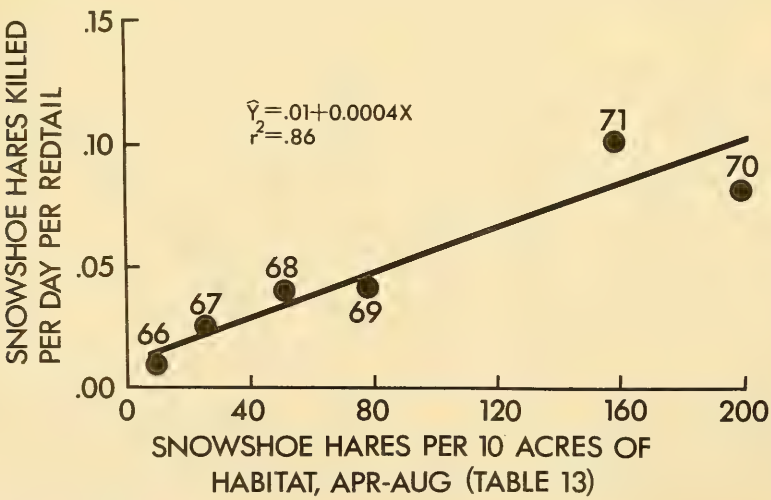

FIGURE 4B. Functional response of Red-tailed Hawks to changing snowshoe hare densities (April–August) near Rochester, Alberta.

TABLE 13. — Estimated total snowshoe hare and Ruffed Grouse numbers on the 62.5-square-mile area (50 square miles in 1966) near Rochester, Alberta[1]

Prey species	1966	1967	1968	1969	1970	1971
Snowshoe hares						
April–May[2]						
(Adults and litter 1)	5,970	12,593	22,572	35,570	107,122	118,483
April–August[3]						
(Adults and litters 1–4)	22,528	44,906	86,777	139,251	346,438	277,358
Ruffed Grouse						
April–May						
(Adults only)	1,632	2,176	3,264	2,176	2,991	2,856
April–June[4]						
(Adults and broods)	8,160	12,621	16,320	11,750	17,348	16,565

[1]Hare habitat comprised 17,600 acres (14,080 in 1966), grouse habitat 13,600 acres (10,880 in 1966) (determined from aerial photos taken in 1968 and corrected for subsequent clearing of forested habitat).
[2]Litter-1 sizes during 1966–1971 averaged 3.3, 3.3, 2.5, 2.7, 2.7, and 2.4, respectively (Keith, L. B. and L. A. Windberg. 1971. Snowshoe hare demography: 1961–71. Annual report to Research Council of Alberta. 30 pp. (mimeo.)).
[3]Total young born in litters 1 through 4 during 1966–1971 averaged 18, 17, 15, 16, 13, and 8, respectively (Keith and Windberg, see footnote 2).
[4]Brood sizes at hatching during 1966–1971 were estimated at 11.2 young, with approximately 80% of the females successfully hatching young (Doerr, P.D., D. H. Rusch, L. B. Keith, and C. A. Fisher. Some demographic characteristics of Ruffed Grouse populations in central Alberta, 1966–1973. Unpublished manuscript.).

between these two raptors. Although the average daily kill of *Microtus* tended to vary directly with population density (Figure 5A), the functional response by red-tails here was much less than they exhibited with snowshoe hares.

The percent biomass of Richardson's ground squirrel in the red-tail diet was unrelated to ground squirrel population trends over the 4-year period, 1968–1971 (Figure 6B). Nor was there any evidence of a functional response in Red-tail predation to changing squirrel densities; the mean daily kill rate remained constant despite a doubling of population (Figure 5B). The relative change in prey density in this case was, of course, much less than among either hares or voles.

Predation Rates

Having considered effects of prey populations on density, distribution, reproduction, and food habits of horned owls and red-tails, we now calculate rates of predation by these raptors on three prey species—snowshoe hares, Ruffed Grouse, and Richardson's ground squirrels. For hares and grouse we could estimate total populations on the entire raptor study area during 1966–1971 (Table 13); for ground squirrels we could only compute relative population densities during 1968–1971.

GREAT HORNED OWL: Numbers of hares taken by Horned Owls rose steadily each year (Table 14, lines 5 and 6) as a result of the strong functional response in diet noted earlier (Figures 3A and 4A) and the marked increase in owl numbers (i.e., numerical response) on the study area (Table 14, lines 1 and 2). Such predation, however, barely kept pace with the increasing hare population (Table 13), and calculated rates of predation varied irregularly between 0.3 and 0.6% (minimum estimate) or 0.5 and 1.1% (maximum estimate) of April--June hare populations (Table 14).

Horned owl predation rates on adult Ruffed Grouse during April–June (Table 14) declined from 4.5–6.6% (1966) to 0 (1969). Losses of grouse to horned owls remained very low through 1970–1971. This pattern of predation losses was opposite to the general trend of Ruffed Grouse populations over the same period (Table 13), and there seems little doubt that its explanation rests with buffering by the greatly expanding hare population. This conclusion is supported by a comparison of ratios of total snowshoe hare to Ruffed Grouse biomass on the study area, which increased progressively from 4 : 1 in 1966 to 41 : 1 by 1971.

RED-TAILED HAWK: The increasing numbers of hares killed by red-tails during 1966–1971 (Table 15, lines 5 and 6) resulted solely from functional responses in food habits, red-tail numbers remaining essentially stationary over this time. As a consequence, rates of predation on the growing hare

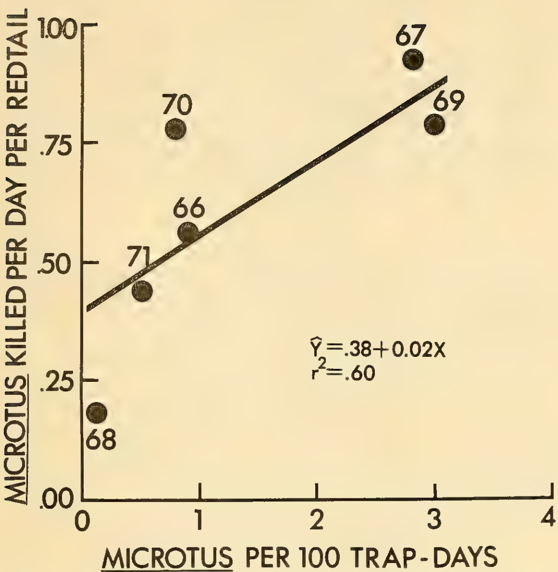

FIGURE 5A. Functional response of Red-tailed Hawks to changing *Microtus* populations (August) near Rochester, Alberta.

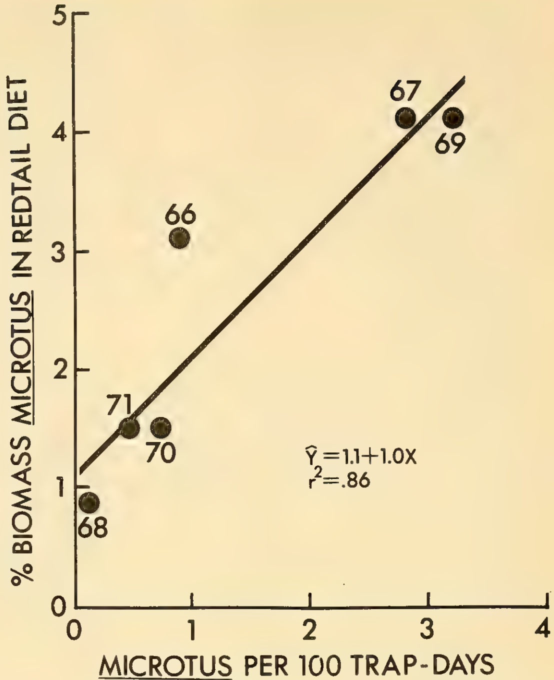

FIGURE 6A. *Microtus* population indices (August) versus percent biomass of *Microtus* in the diet of Red-tailed Hawks near Rochester, Alberta.

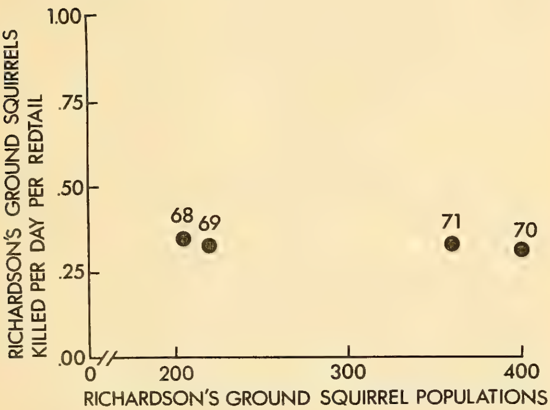

FIGURE 5B. Functional response of Red-tailed Hawks to changing Richardson's ground squirrel populations (April) near Rochester, Alberta.

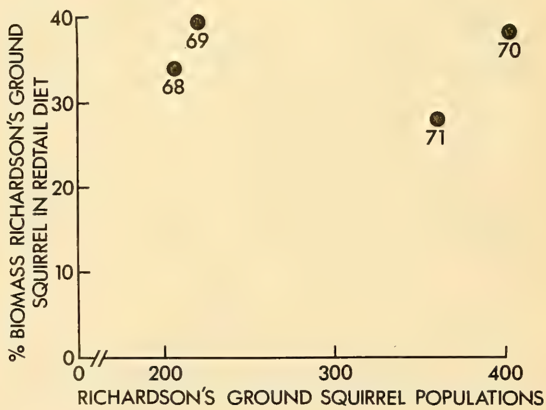

FIGURE 6B. Richardson's ground squirrel population indices (April) versus percent biomass of ground squirrels in the diet of Red-tailed Hawks near Rochester, Alberta

population tended to be slightly lower during April–August 1969-1971 than in 1966–1968 (Table 15). Minimum estimates of predation rates ranged from 0.2% (1969–1970) to 0.6% (1967), and maximum estimates from 0.4 to 1.0%.

Predation on adult and juvenile Ruffed Grouse declined in 1970–1971 from the preceding 2 years (Table 15). The buffering effect of the high hare population seems to have occurred later among redtails than among horned owls. Rates of predation

TABLE 14. — Calculation of predation rates by Great Horned Owls on snowshoe hare and Ruffed Grouse populations on the 62.5-square-mile study area (50 square miles in 1966) near Rochester, Alberta, 1 April–30 June

	1966	1967	1968	1969	1970	1971
Number of adult owls	10	12	16	18	14	32
Number of young owls fledged	2	7	9	15	18	28
Number of owl-days on area						
Adults and fledged young	942	1204	1602	1878	1514	3312
Nestlings	120	363	386	835	953	1471
Number of prey consumed[1]						
Snowshoe hares[2]						
Estimate A	29	51	107	197	369	755
Estimate B	43	93	239	274	564	1318
Ruffed Grouse[3]						
Estimate A	74	27	26	0	6	4
Estimate B	107	46	52	0	18	10
Percent of prey population consumed						
Snowshoe hares						
Estimate A	0.5	0.4	0.5	0.6	0.3	0.6
Estimate B	0.7	0.6	1.0	0.8	0.5	1.1
Ruffed Grouse						
Estimate A	4.5	1.2	0.8	0.0	0.2	0.1
Estimate B	6.6	1.8	1.5	0.0	0.5	0.3

[1]Estimate A based on the assumption that biomass of prey killed and biomass of prey consumed were identical; estimate B based on the assumption that biomass of prey killed was greater than biomass of prey consumed. See explanation in text.
[2]Juvenile hares observed in owl diet during 1966–1971 averaged 0, 0, 0, 14, 18, and 21% of the total hare kill, respectively.
[3]All Ruffed Grouse consumed by owls in this period were adults, with a significantly unbalanced sex ratio in favor of males (Rusch et al. 1972).

TABLE 15. — Calculation of predation rates by Red-tailed Hawks on snowshoe hare and Ruffed Grouse populations on the 62.5-square-mile study area (50 square miles in 1966) near Rochester, Alberta, 15 April–31 August

	1966	1967	1968	1969	1970	1971
Number of adult hawks	48	53	48	42	43	42
Number of young hawks fledged	20	26[1]	10	21	15[1]	17
Number of hawk-days on the area						
Adults and fledged young	8568	8255	7099	6898	6849	6678
Nestlings	1054	1352	922	1107	1541	975
Number of prey consumed[2]						
Snowshoe hares[3]						
Estimate A	101	251	316	313	689	774
Estimate B	167	434	531	522	1304	1463
Ruffed Grouse[4]						
Estimate A	89	67	178	127	86	27
Estimate B	141	107	287	195	165	50
Percent of prey population consumed						
Snowshoe hares						
Estimate A	0.4	0.6	0.4	0.2	0.2	0.3
Estimate B	0.7	1.0	0.6	0.4	0.4	0.5
Ruffed Grouse						
Estimate A	1.1	0.5	1.1	1.1	0.5	0.2
Estimate B	1.7	0.8	1.8	1.7	1.0	0.3

[1]Five young in 1967 and one in 1970 fledged but were not tethered.
[2]Estimate A based on the assumption that biomass of prey killed and biomass of prey consumed were identical; estimate B based on the assumption that biomass of prey killed was greater than biomass of prey consumed. See explanation in text.
[3]Juvenile hares observed in hawk diet during 1966–1971 averaged 30, 56, 59, 70, 47, and 59% of the total hare kill, respectively.
[4]Juvenile grouse observed in hawk diet during 1966–1971 averaged 71, 71, 82, 79, 71, and 75% of total grouse kill, respectively.

(minimum estimates) were highest in 1966 and 1968–1969 at 1.1% and lowest in 1971 at 0.2%.

Since we could not expand known densities of Richardson's ground squirrels to the entire raptor study area, it was impossible to estimate overall rates of predation. We therefore used relative population levels and calculated predation-rate indices (Table 16). During 1968–1971, ground squirrel densities about doubled, while predation rates halved. Thus exploitation rates on ground squirrels varied inversely with population density. An immediate cause of this situation was the complete absence of any functional response by red-tails—average numbers of squirrels taken per day per red-tail remained constant (Figure 5B). The ultimate explanation, however, may rest once again with a buffering of the red-tail diet by hares during their cyclic peak of 1970–1971.

Discussion

There are four basic components to predator–prey interactions (Leopold 1933, p.231;

TABLE 16. — Indices of predation rates by Red-tailed Hawk on Richardson's ground squirrel populations on part of a 62.5-square-mile study area near Rochester, Alberta

	1968	1969	1970	1971
Number of ground squirrels consumed[1]				
Estimate A	1164	1206	1443	902
Estimate B	1732	2023	2668	1705
Relative levels of ground squirrel populations[2]	1.0	1.1	2.0	1.8
Predation rate index[3]				
Estimate A	2.3	2.2	1.4	1.0
Estimate B	1.8	1.9	1.4	1.0

[1]Estimate A based on the assumption that biomass of prey killed and biomass of prey consumed were identical; estimate B based on the assumption that biomass of prey killed was greater than biomass of prey consumed. See explanation in text.

[2]Relative levels were used for ground squirrel populations because we did not know the total amount of ground squirrel habitat on the 62.5-square-mile study area; calculated from data collected from three to five pastures within the raptor study area.

[3] $\frac{\text{(Number of ground squirrels consumed)}}{\text{(Relative levels of ground squirrel populations)}}$, expressed in relative terms.

Holling 1959): (1) prey density, including buffer species; (2) predator density; (3) behavioral characteristics of prey, such as response to predation; and (4) behavioral characteristics of predators, such as efficiency, food preferences, etc. Holling (1959) stated that density of prey, and density of predators are the only variables necessary to describe the fundamental attributes of predation. Predator population response to prey populations is of two types (Solomon 1949): *numerical*–a change in predator density, and *functional*–a change in numbers of prey consumed by individual predators.

In the following discussion we examine the magnitude of such responses by Great Horned Owls and Red-tailed Hawks at Rochester, and the implications of buffering and territoriality.

Numerical Response

The horned owl population increased from five resident pairs in 1966 to at least 16 in 1971 (Table 3). The proportion of resident pairs breeding rose from only one of five in 1966 to eight of eight by 1968; the breeding rate probably remained at 100% through 1971. There was a significant increase in average clutch size in 1970 (Figure 1), but a decline in 1971 to near the 1966–1969 mean. Nestling mortality was highest (25%) in 1968 (Table 3). Some yearling owls may have nested in 1971 but not in previous years; the evidence here is not conclusive, however.

Although we lack census data or indices for such common prey as pocket gophers and waterfowl, the most significant numerical responses by our horned owl population were undoubtedly related to the cyclic increase of snowshoe hares. In April 1971, adult hare densities averaged nearly 2,000 per square mile, while peak densities in fall 1970 had been 4,000–6,000 per square mile (Keith, unpublished). The rise in horned owl numbers and breeding rates paralleled the increase in hares during 1966–1971, and the growing importance of hares as the staple food for horned owls over this period is obvious (Table 8). By 1971 they comprised 81% of the total biomass of prey taken. Relationships between the hare population and larger clutches in 1970, and increasing nestling survival during 1968–1971, are less clear-cut. A high population of *Microtus* has been strongly implicated in the clutch-size increase, but such other facets of reproduction as earliness of nesting and possible yearling breeding seem more likely to have involved the hare population.

In sharp contrast to the horned owl populations, those of the Red-tailed Hawk were essentially stationary during 1966–1971 (Table 4), and breeding rates were consistently high (about 90%). There was no indication of an earlier onset of nesting when hare populations were near their peak, nor of yearlings entering the breeding cohort. The only similarities between the two raptors were highest mortality of nestlings during 1968, and a significant increase in mean clutch size during 1970, neither of which may be associated with hare population levels.

This absence of numerical responses by red-tails is almost certainly linked to their migratory status at Rochester. They are present from early April until September or October, during which time prey are generally abundant, diverse, and exposed. Horned owls, on the other hand, are year-round residents, subject to the stresses of cold and potential food-shortage during winter. When hares and grouse are scarce there are few alternative and available prey species. Most small-mammal activity is subnivean, and there is a paucity of overwintering songbirds. We believe that the depressed breeding rates of horned owls in 1966 and 1967 were a direct result of food scarcity during the preceding winters. This

likely affected the owls' physical and/or physiological condition, and hence their ability or inclination to nest. Hare and grouse populations were just beginning to recover from a cyclic low at that time. The numerical increase of horned owls appears, therefore, to be importantly a function of renewed recruitment of young, with hare (and perhaps initially Ruffed Grouse) populations being the determining factor. We suspect also that post-fledging survival of juveniles is improved by increasing hare densities, but have no way of testing this hypothesis.

If, as implied above, there is an adequate though varying prey base to support our raptor populations in summer, then the observed numerical stability of breeding red-tails must be independent of prey densities. It seems to us that red-tail populations at Rochester are being both limited and spaced (Table 5) by intense territoriality, whereas to date, spacing alone has been the principal effect of territoriality among horned owls. In 1971 the latter were, of course, just approaching red-tail densities.

Functional Response

The notable functional responses (Figure 4A, B) by horned owls and red-tails to increasing snowshoe-hare populations reflect (1) a greater proportion of hares in the diet (Figure 3A, B), and (2) a greater total biomass of prey killed (Table 10). In neither species, however, did the magnitude of functional response match that of the hare population increase; and only with horned owls, where functional and numerical responses were combined, did overall rates of predation on hares tend not to decline (Tables 14, 15). There was also a functional response of red-tails to changing *Microtus* populations (Figure 5A); here again the ratio of change in numbers consumed was much less than the ratio of change in the prey population.

Apparent buffering of raptor predation has been noted several times in the present paper. It is important to distinguish between the buffering of prey species in raptor diets, and the buffering of rates of raptor predation on prey populations. The relationship between the two is contingent on accompanying changes in the prey population, and the degree of numerical and functional response by the predator. To illustrate, during April–June 1966–1969, (1) the relative biomass of hares in the horned owl diet rose 2.2 times from 23 to 50% (Table 8), while that of Ruffed Grouse declined from 23% to 0; (2) the total number of hares taken actually increased sevenfold from 29 to 197 (Table 14), while numbers of Ruffed Grouse taken fell from 74 to 0; and (3) the predation rate on the hare population rose only by a factor of 1.2 from .49 to .55 (Table 14), while the predation rate on Ruffed Grouse dropped from 4.5% to 0. In the above example, the percent biomass of hares in the raptor diet increased almost twice as much as the rate of predation on the hare population, and the percent biomass of grouse in the diet decreased five times as much as the rate of predation on the grouse population.

Acknowledgments

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Mammals of the Sandhills of Southwestern Manitoba

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Abstract. The sandhills and sandy plains of extreme southwestern Manitoba have supported within recent times a total of 63 species of mammals, two-thirds of which reach their limits of distribution in or near this region. Thirty-six percent of the mammalian fauna is composed of widespread species, 30% is characteristic of the Coniferous Forest Biome, 19% of the Grassland Biome, 13% of the Temperate Deciduous Forest Biome, and 2% introduced. The white-tailed jack rabbit, eastern cottontail, gray squirrel, fox squirrel, raccoon, and white-tailed deer have expanded their ranges into Manitoba within the last 100 years. New range extensions are reported for the Keen bat, big brown bat, gray squirrel, fox squirrel, northern flying squirrel, olive-backed pocket mouse, northern grasshopper mouse, prairie vole, western jumping mouse, and cougar. The zonation of mammals is described within the major plant communities—hydroseres and xeroseres leading to several climaxes Diverse plant communities between the peaks and valleys of sand dunes result in the proximity of species of mammals with widely different habitat requirements (e.g., olive-backed pocket mouse, eastern chipmunk, and water shrew). The number of species and individuals respectively present on 2-hectare quadrats were: Riparian Forest, 14 (65); Mixed Savanna, 15 (39); Xeric Shrub, 13 (100); Mesic Prairie, 9 (142); Xeric Prairie, 4 (17).

Introduction

Extensive areas of southwestern Manitoba are covered by sand and sandy loam deposits originating from basins and deltas of the former glacial lakes Agassiz and Souris. Dunes have formed at many localities, the largest of which are the Bald Head Hills in the Carberry Sandhills, up to 23 meters above the surrounding plain and 70 meters above the Assiniboine River. These sandhills and plains support a great variety of plant communities, influenced largely by availability of soil moisture and exposure. Mixed-grass prairie, aspen–oak savanna, aspen–oak forest, elm–maple–ash riparian forest, and marsh are the dominant types of vegetation, but the Carberry Sandhills also harbor relict populations of white spruce, black spruce, and tamarack. Southwestern Manitoba, and in particular the Carberry Sandhills, is located geographically at a three-zone transition between the Grassland, Coniferous Forest, and Temperate Deciduous Forest biomes. Consequently, many species of mammals reach their distributional limits here, and species with variant centers of dispersal and habitat requirements are found living within a few meters of each other (e.g., olive-backed pocket mouse, water shrew, eastern chipmunk).

The sandhills of southwestern Manitoba are of considerable historic interest. Records of mammalian distribution and abundance have been summarized from the early 1800's by Seton (1909), Criddle (1929), and Soper (1946, 1961). Certain species quickly disappeared from this area with the arrival of European hunters and trappers, while many other species have greatly altered their range either as a result of natural dispersal or of man's activities. The objectives of the present study were (*a*) to determine the past and present status of mammals in this region, (*b*) to study their zonation within the major plant communities, and (*c*) to determine the number of species and individuals of mammals occurring on 2-hectare (4.9-acre) quadrats in Riparian Forest, Mixed Savanna, Xeric Shrub, Mesic Prairie, and Xeric Prairie.

Materials and Methods

Manitoba Museum field parties spent a total of 31 days between March and October from 1970 to 1972 studying a variety of habitats at

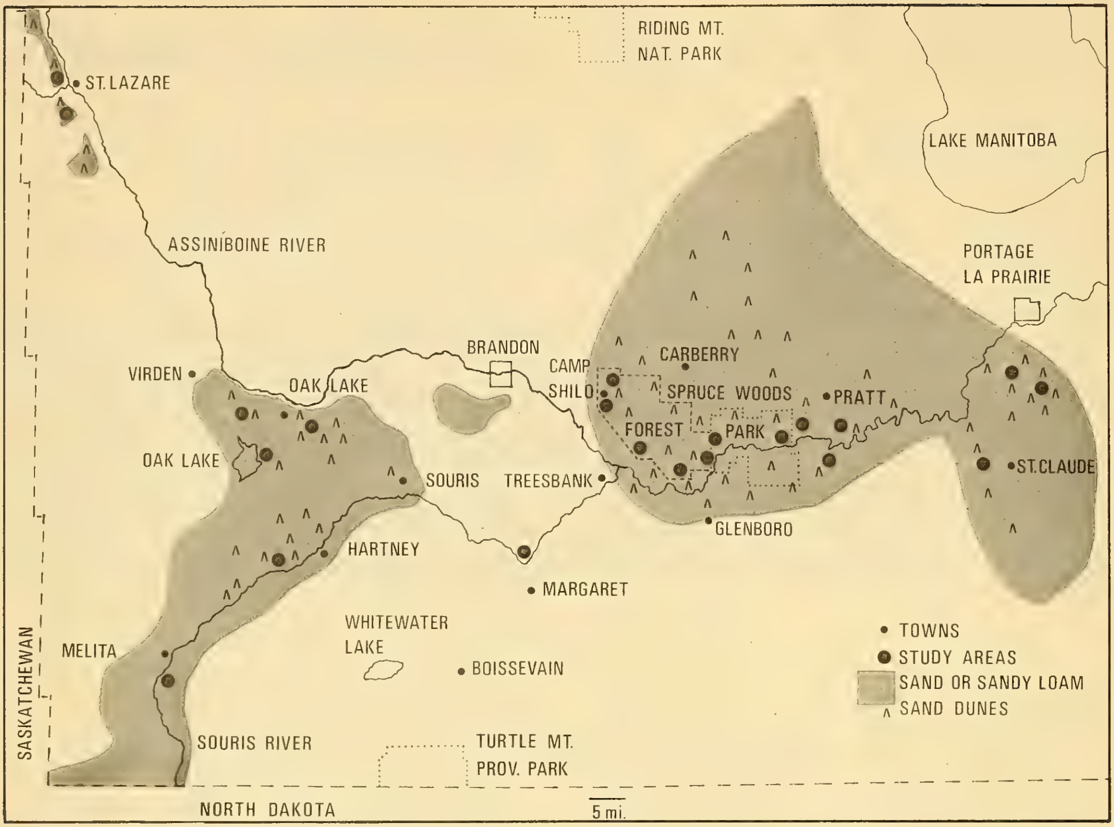

FIGURE 1. Map of extreme southwestern Manitoba showing place names, study areas, and distribution of sand dunes and sandy plains.

55 localities in southwestern Manitoba (Figure 1). Museum biologist David Hatch, a resident of Oak Lake for many years, contributed observations from this district, and Mr. Larry Bidlake, Mr. Eugene Bossenmaier, and Mr. Merlin Shoesmith, of the Manitoba Department of Mines, Resources, and Environmental Management, added recent records of big-game and fur-bearing species. In addition to observations of 23 species of mammals, 1814 specimens of 26 other species were obtained.

Mammals were collected by several methods and procedures: (*a*) shooting with .22/.410 rifle/shotgun, (*b*) capturing pocket mice by hand after dark, (*c*) setting lines of museum special mousetraps for one to three nights in all major plant communities, (*d*) measuring five 2-hectare quadrats and setting the following traps on each for 3 nights — 400 mousetraps, 20 rattraps (set in trees and on ground), 12 pitfall pitfall traps (1-quart juice or oil tin), 10 Conibear steel traps (weasel size), and Macabee pocket gopher traps All mammals were frozen with dry ice and later prepared as standard museum specimens.

Climate

In extreme southwestern Manitoba the length of the growing season (days over 42°F) is 165 to 180 days, while the frost-free period extends from 90 to 110 days. The mean annual snowfall at various localities ranges from 102 to 122 centimeters (40 to 48 inches), the median snow depth for January and February ranges from 20 to 31 centimeters (8 to 12 inches), and a snow cover is usually present

from November to March. The average precipitation from April to September at various localities ranges from 15 to 31 centimeters (6 to 12 inches), and 10 to 20 centimeters (4 to 8 inches) from October to March. The temperatures in July and January average 65 to 68°F and −1 to 4°F respectively (The National Atlas of Canada, The Economic Atlas of Manitoba, and the Atlas of the Prairie Provinces).

Plant Communities

Series A of Figure 2 illustrates the major plant communities present in the Carberry Sandhills and, with the absence of white spruce, most other sandy areas of southwestern Manitoba. At some sites in the Carberry Sandhills both hydrosere and xerosere appear to reach a climax of white spruce. Pure white spruce stands are found on elevated, stabilized sand dunes as well as on poorly drained sites between the dunes, particularly in oxbows (Figure 3). Deciduous riparian forest, aspen–oak forest, and mixed-grass prairie are other climax communities throughout much of the region. The following list summarizes the occurrence, soil condition, and dominant plants of each community.

Marsh: a narrow zone of aquatic vegetation on muck soil, found along creeks, rivers, and oxbows. *Carex* spp., *Sagittaria cuneata, Typha latifolia.*

Hydric Shrub: usually a narrow band of shrubs on alluvial soil along watercourses, but also present in moist sites in meadows. *Salix interior, S. lutea, Alnus crispa, Cornus stolonifera.*

Meadow: grass and sedge growth on mull or alluvium in moist areas where shrubs and trees have not yet invaded. *Calamagrostis* sp., *Spartina pectinata, Beckmannia syzigachne, Carex* spp., *Bromus inermis.*

Floodplain Broadleaf Deciduous Forest: usually a narrow zone of forest but occasionally up to 100 meters from a watercourse; moist alluvial soil with much organic matter (Figure 4.). *Ulmus americana, Acer negundo, Fraxinus pennsylvanica, Aralia nudicaulis, Matteuccia struthiopteris,* grasses, mosses.

Mesic Broadleaf Deciduous Forest: forest present over much of the region, developing on old dunes and sand plains; dense shrub layer; soil is a sandy mull with a thick layer of litter, considerably drier than the floodplain. *Populus tremuloides, Quercus macrocarpa, Betula papyrifera, Corylus americana, C. cornuta, Amelanchier alnifolia, Prunus* spp., *Ribes* spp., *Aralia nudicaulis, Rhus radicans.*

Mixed Forest: found only in the Carberry Sandhills. Similar to the above forest with the addition of *Picea glauca, Viburnum* sp., and *Rosa* sp.

FIGURE 3. Oxbow in the Carberry Sandhills with pond, marsh, hydric shrub, meadow, needleleaf evergreen forest, mixed forest, and dune pioneer communities.

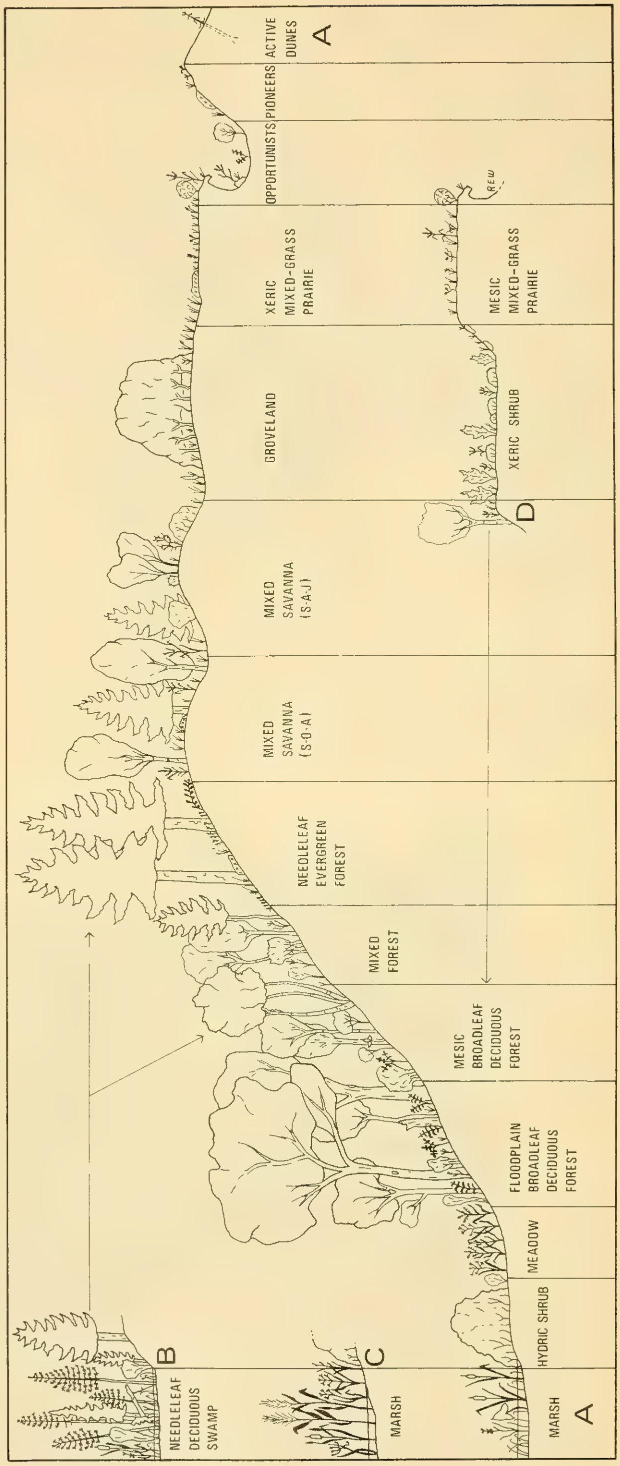

FIGURE 2. Zonation of plant communities in southwestern Manitoba. Series A is typical of the Carberry Sandhills and, with the exception of white spruce, most other areas. Series B is a relic community of tamarack and occasional black spruce present only in the Carberry Sandhills. Series C is a marsh community at Oak Lake, and Series D represents terrace communities above the Souris River.

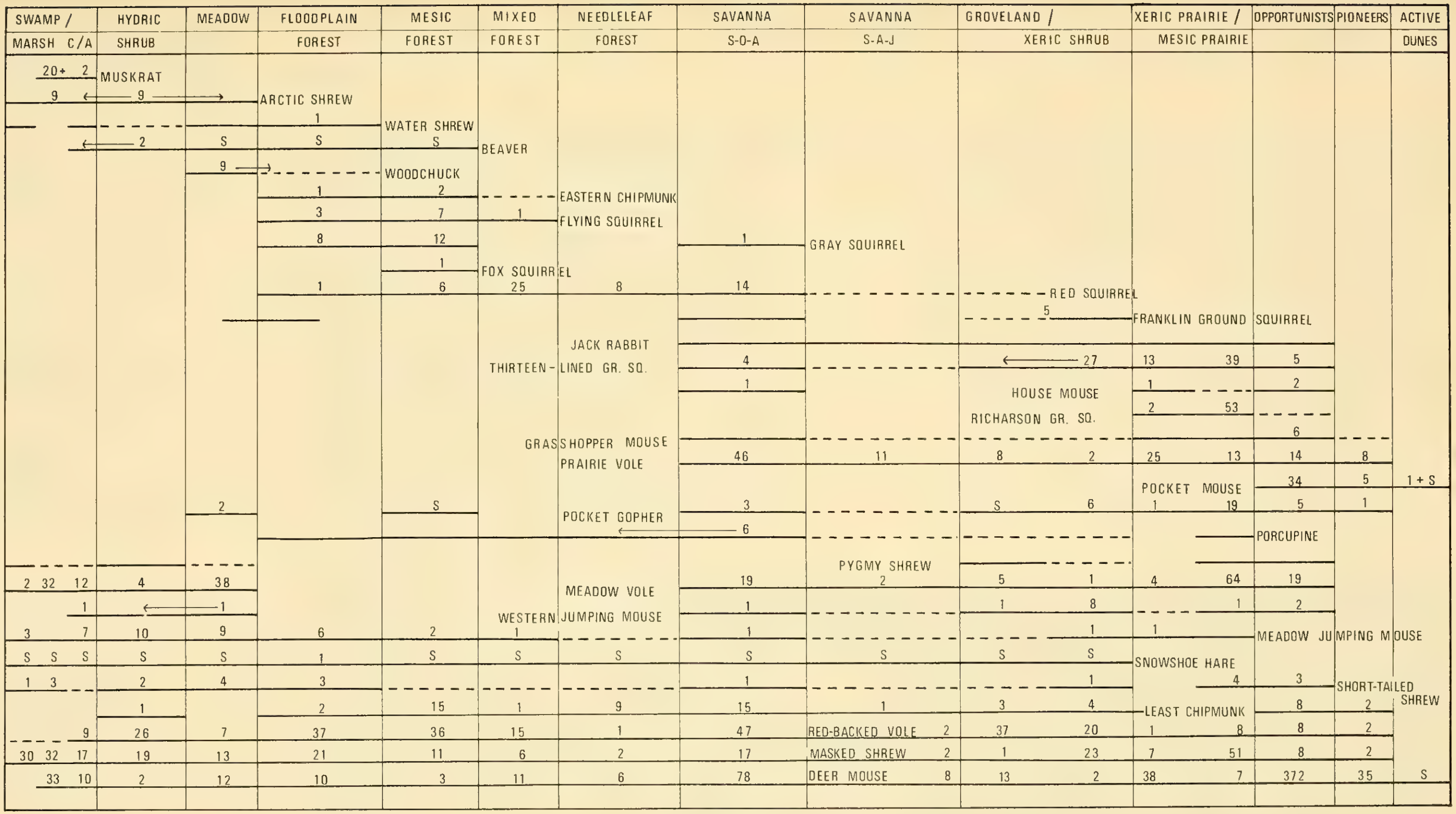

TABLE 1. — Zonation of small mammals (Insectivora, Lagomorpha, Rodentia) in the major plant communities of southwestern Manitoba. Numbers refer to mammals collected and observed in this study. Solid lines without numbers indicate the presence of species through other sources, while dashed lines refer to the probable occurrence of species in that community.

FIGURE 4. Floodplain Broadleaf Deciduous Forest; part of the Riparian Forest Quadrat at 6.5 miles north of Glenboro (3–5 July 1972).

Needleleaf Evergreen Forest: occurs on well and poorly drained sites on the slopes and valleys of sand dunes: soil is sand or mor. *Picea glauca, Juniperus horizontalis, Arctostaphylos uva-ursi, Oryzopsis asperifolia, Cornus canadensis, Chimaphila umbellata,* mosses, lichens.

Mixed Savanna (Spruce–Oak–Aspen): a very common plant community in the Carberry Sandhills and, with the absence of white spruce, also in other areas; sandy soil is well drained with a thin layer of litter and humus (Figure 5). *Picea glauca, Quercus macrocarpa, Populus tremuloides, Cornus* spp., *Symphoricarpos occidentalis, Eleagnus commutata, Juniperus horizontalis, J. communis, Andropogon gerardi, Festuca ovina.*

Mixed Savanna (Spruce–Aspen–Juniper): occurs most often on sand plains and gently rolling, stabilized dunes; spruce and small aspen stands are widely spaced while junipers form a carpet amid bunch grasses and cacti, with sand exposed in places; little humus or litter on dry sand. *Picea glauca, Populus tremuloides, Juniperus horizontalis, J. communis, Betula occidentalis, Salix* sp., *Arctostaphylos uva-ursi, Bouteloua gracilis, Stipa* spp., *Andropogon scoparius, Opuntia fragilis, Mamillaria vivipara.*

Groveland: aspen groves dispersed on flat or gently rolling plains of xeric mixed-grass prairie; a thick layer of litter over mull soil within the groves; little humus or litter under spaced bunch grasses, forbs, and juniper. *Populus tremuloides, Stipa spartea, S. comata, Bouteloua gracilis, Koeleria cristata, Andropogon scoparius, Juniperus horizontalis, Astragalus caryocarpus, Artemesia* spp., *Arctostaphylos uva-ursi.*

Xeric Mixed-grass Prairie: same as groveland prairie without the aspen; hot, arid sand plains with open patches of sand between the plants (Figure 8).

Opportunists: plants invading disturbed sites in savanna and grassland (blowouts, fire breaks, trails, roadways); many weedy species with abundant seed. *Elymus canadensis, Artemesia* spp., *Rosa* spp., *Amaranthus* spp., *Polygonum convolvulus, P. achoreum, Chenopodium album, Bromus inermis.*

Pioneers: plants colonizing dunes. *Elymus canadensis, Lygodesmia juncea, Corispermum hyssopifolium, Rumex venosus, Lithospermum incisum, Carex* spp., *Lepidium* spp., *Salix interior, Betula occidentalis.*

Series B represents a relict community of tamarack swamp found only in the Carberry Sandhills along the shores of Sewell Lake, Epinette Creek, and at isolated sites with poor drainage between the dunes. A submerged muck or peat layer is present over the sand, covered by a quaking sedge mat. Locally there are dangerous areas of quicksand. With increased drainage up the slopes, tamarack swamp is replaced by white spruce or mixed forest.

Needleleaf Deciduous Swamp: *Larix laricina, Salix* spp., *Cornus stolonifera, Betula glandulosa, Picea mariana, Carex* spp., *Typha latifolia,* grasses, mosses.

Series C represents a marsh community found along the shores of Oak Lake, southwest of the town of Oak Lake. Each of the five dominant plants forms rather distinct stands. The marsh was relatively dry when studied in October, the muck drying hard in some places.

Marsh: *Scirpus* spp., *Typha latifolia, Phragmites communis, Scolochloa festucacea, Carex atherodes.*

Series D represents terrace communities present along the Souris River north of Margaret. While the north-facing slope is completely forested, the south-facing slope supports a riparian forest, above which are two broad terraces of mixed-grass prairie, then a predominantly shrub-covered terrace, and finally

FIGURE 5. Mixed Savanna (Spruce–Oak–Aspen) Quadrat at 7 miles north of Glenboro (1–3 June 1971).

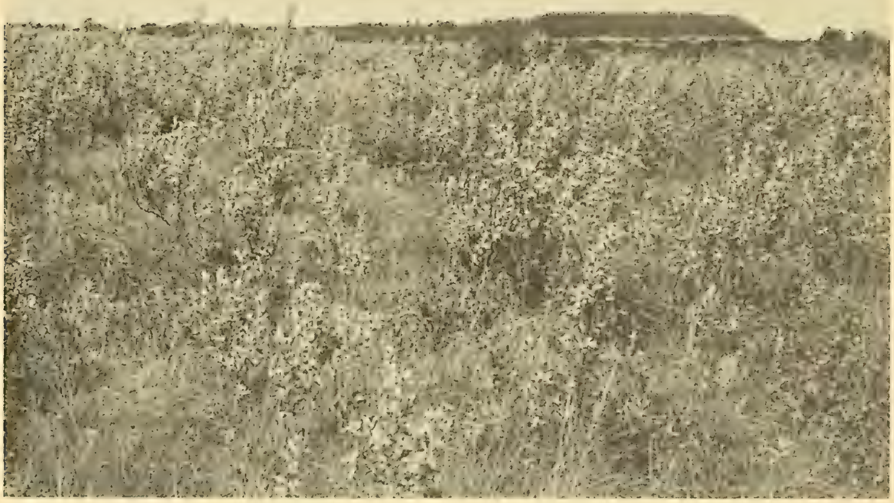

FIGURE 6. Xeric Shrub Quadrat at 4 miles north, 0.5 miles west of Margaret (7–9 August 1972).

an upland deciduous forest with open bluffs. The order of the prairie and shrub habitats are reversed in Figure 2, to correspond to similar habitats in Series A. The soil is a mull, overlying sandy alluvium.

Xeric Shrub: silverberry shrubs scattered fairly uniformly among grasses; snowberry shrubs occurring in dense thickets, often shading out undergrowth (Figure 6). *Symphoricarpos occidentalis, Eleagnus commutata, Rubus* sp., *Prunus* sp., *Stipa spartea,* S. *comata, Andropogon gerardi, A. scoparius, Artemesia* sp.

Mesic Mixed-grass Prairie: more luxurious growth of grasses and forbs than in xeric prairie, as a result of less sandy soil and more moisture (Figure 7). *Stipa spartea, S. comata, Bouteloua gracilis, Andropogon scoparius, Koeleria cristata, Solidago* sp., *Artemesia* sp., *Anemone cylindrica, A. patens, Rosa* spp.

FIGURE 7. Mesic Prairie Quadrat at 3.8 miles north, 0.5 miles west of Margaret (8–10 August 1972).

FIGURE 8. Xeric Prairie Quadrat at 2.7 miles south, 0.5 miles east of Shilo (4–6 July 1972).

Species Accounts

Sorex cinereus: the masked shrew was found in every habitat type except barren sand dunes (Table 1). Greatest numbers occurred in hydric and mesic communities with a mull humus layer, which supported abundant invertebrates. The type of cover (tree, shrub, herb) seemed relatively unimportant, and surprisingly, a few individuals were collected in sandy prairie with little cover, subject to temperature extremes and low soil moisture. Total collected in the present study was 262 specimens.

Sorex palustris: the water shrew occurs in the area only as a southern relict population in the Carberry Sandhills (Table 3). A single specimen was obtained

in this study, in a floodplain broadleaf deciduous forest (6.5 miles north of Glenboro). The site was on saturated soil, under the cover of ostrich ferns and rotting logs, about 140 meters from a creek. Seton (1909) collected one specimen in the sedge growth of a slough at Carberry (a general locality name for the whole Carberry Sandhills), and Criddle (1929) trapped several specimens in a tamarack swamp bordering the Assiniboine River near Treesbank. The nearest records to the north are one specimen from Delta, and Riding Mountain National Park where it is relatively abundant (Museum field party collected 34 water shrews here seven nights). Total 1 specimen.

Sorex arcticus: the arctic shrew is a rare species occurring in disjunct populations on the southern edge of its range. One specimen was found in willow–sedge–grass along the Souris River (4.5 miles north, 0.5 miles west of Margaret), nine in grass–sedge–cattail marsh along the east shore of Oak Lake, and eight in willow shrubs – meadow (10 miles south of Portage la Prairie). Seton (1909) caught two arctic shrews at Carberry and Criddle (1929) collected several in the tamarack swamp along Epinette Creek east of Shilo. Total, 18 specimens.

Microsorex hoyi: though over 300 shrews were trapped in this study, not a single pygmy shrew was among them. A greater use of pitfall traps would probably have secured this species but it must be very rare and localized here on the southern edge of its range. Criddle (1929) described the pygmy shrew as rare in the Carberry Sandhills, and collected at least one dozen specimens over several decades. Habitats listed on the labels include tamarack swamp, willow shrubs, prairie, aspen groves, and disturbed sites.

Blarina brevicauda: the short-tailed shrew occurred in a wide variety of habitats but was nowhere common. Probably it inhabits all plant communities except the driest prairie and barren dunes. The study area is close to the western edge of its range and consequently this species was found at only six localities (vicinities of Glenboro, Margaret, Portage la Prairie, Holland, Pratt, and Oak Lake). The only other records in extreme southwestern Manitoba are Turtle Mountain (Soper 1961), Carberry Sandhills, and Ninette, where Criddle (data from labels) found this shrew in prairie and tamarack swamp. Total, 22 specimens.

Myotis lucifugus: the little brown bat was uncommon and only a few individuals were observed around

TABLE 2. — Species and numbers of mammals found on the five 2-hectare quadrats

Species	Riparian Forest	Mixed Savanna	Xeric Shrub	Mesic Prairie	Xeric Prairie
Masked shrew	21	2	23	21	
Water shrew	1				
Short-tailed shrew	1		1		
Snowshoe hare	Sign	Sign			
Eastern chipmunk	3				
Least chipmunk	3	2	2		
Thirteen-lined ground squirrel		4	27	37	3
Franklin ground squirrel			3		
Red squirrel	1	3			
Northern flying squirrel	3				
Northern pocket gopher	Sign	3	12	21	3
Beaver	Sign				
Deer mouse	5	11	2	1	4
Red-backed vole	17	6	17	3	
Meadow vole		2	1	46	
Prairie vole		5	2	11	7
Meadow jumping mouse	9	1	1		
Western jumping mouse			8	1	
Porcupine		Sign			
Coyote		Sign			
Elk		Sign			
White-tailed deer	1	Sign	1	1	
Total individuals	65	39	100	142	17
Total species	14	15	13	9	4

farm buildings and towns in the area. The Manitoba Museum has one specimen from Brandon and five from Max Lake (Turtle Mountain). The University of Manitoba Museum has two specimens that Criddle collected at Treesbank and Wawanesa.

Myotis keenii: the only records of the Keen bat in Manitoba are two specimens from Souris (Criddle 1932), and four north of the study area at The Pas and 14 miles south of Gypsumville (northern peripheral records), in the collection of Mr. S. Waller of The Little Northern Museum, The Pas, Manitoba.

Lasionycteris noctivagans: the University of Manitoba Museum has four specimens of the silver-haired bat collected by Criddle (1929) at Treesbank, where it was described as tolerably common.

Eptesicus fuscus: the big brown bat has been reported as far north as Lake Winnipeg (Seton 1909) and Cedar Lake, 70 miles southeast of The Pas (Waller, personal communication), and although there are no records in the study area, it probably occurs here in small numbers.

Lasiurus borealis: the red bat was first reported in southern Manitoba by Seton (1909) with three specimens from Morden and two from Winnipeg. Criddle (1929) described it as fairly common near Treesbank. The University of Manitoba Museum has three specimens from Treesbank, and single records, which Criddle collected, from Rock Lake and Pelican Lake (Strathcona Municipality).

Lasiurus cinereus: Seton (1909) reported the hoary bat as common in southern Manitoba (about one dozen specimens at Carberry, Morden, and Winnipeg), as did Criddle (1929) in the Treesbank area. The University of Manitoba Museum has one specimen from the Tiger Hills (northeast of Margaret), and I examined a photograph of a specimen resting in a willow shrub at Souris. Over a number of years Hatch (personal communication) observed about one dozen individuals in wild plum trees near the marshes of Oak Lake.

Sylvilagus floridanus: the northwestern expansion of the eastern cottontail's range in Manitoba was summarized by Soper (1961): it appeared first at Emerson on the Red River, and reached the forks of the Antler and Souris Rivers by 1927. Criddle (1929) reported the first specimen in the Carberry Sandhills area in 1914, and the University of Manitoba Museum has two of his specimens from Treesbank and one from Killarney. This species has since reached many localities north of the study area but is not very common.

Lepus americanus: the snowshoe hare had recently entered the low phase of its population cycle during the study period, and only one individual was observed (in the floodplain forest of the Carberry Sandhills). Droppings, browsing sign, and tracks in the snow were seen in all habitats with cover (marsh, shrub, tree) but not over extensive open prairie and dunes. Soper (1961) reported this species at Rock Lake and the fork of the Antler and Souris Rivers. Seton (1909) described a peak in population numbers in 1886, with 20/acre in the poplar belt around Carberry. Other peaks were reported in 1922–1923 and 1933–1934 in the Carberry Sandhills (Criddle 1938), and in 1942–1943 (Soper 1961).

Lepus townsendii: from Seton's (1909) survey of early accounts the white-tailed jack rabbit was not found in Manitoba within historic times until around 1881, when the first specimen was collected at Boissevain. Another was taken at Carberry in 1892, after which the species became so numerous that 20 could be seen in a mile. By 1898 jack rabbits abounded all over the prairie region of Manitoba, causing crop damage at Napinka where they were extremely abundant. Criddle (1929) collected the first specimen at Treesbank in 1890, whereafter they became common in that area. Hatch (personal communication) reported them as very abundant in the Oak Lake area in the 1930's, low in the 1940's, increasing slightly until 1955 when groups of 15 to 20 could be seen at a time; since then populations have been very low. None was seen in the present study but it occurs over savanna, prairie, and agricultural habitats.

Tamias striatus: the eastern chipmunk reaches its western limit in this area. Seton (1909) described it as common near Portage la Prairie but absent from Carberry. Criddle (1929) later reported this species as tolerably common in the Carberry Sandhills in woods along rivers, though only three individuals were observed here in the present study (Riparian Forest Quadrat). Two of these were in aspen–oak–birch forest and one in elm-maple-ash forest.

Eutamias minimus: the least chipmunk was present in all communities with shrub or tree cover and specimens were collected at most localities. Moisture conditions did not appear to be a dominant factor controlling local distribution, as this species was found in shrubs along streams, through many types of forest and savanna to patches of shrubs on dry prairie. The majority were taken in aspen–oak forest and savanna, spruce forest, and in the vicinity of disturbed sites. The least chipmunk extends south in this region only to the junction of the Antler and Souris Rivers (Soper 1946). Total, 45 specimens.

Marmota monax: the woodchuck is a rare species in this region, on the southwestern limits of its range. Seton's (1909) map shows it to be absent from much of the area, with one record from the Souris River north of the Turtle Mountains, and three from the Carberry and Brandon Hills. Criddle (1929, 1932)

reported two individuals from the Treesbank area, and Soper's (1971) field notes described observations from the Turtle Mountains and Pelican Lake. Only nine were seen in this study, three in meadows in the Spruce Woods Provincial Park, a family of four at Virden, and single individuals at Oak Lake and St. Lazare, all at the edge of riparian forest. The sandy nature of the soil and the dry prairie vegetation may be influential in restricting the woodchuck to meadows and open forests near streams.

Spermophilus richardsonii: the Richardson ground squirrel was reported by Seton (1909) as exceedingly abundant (up to 50/acre) in southwestern Manitoba, and Soper (1971) noted its presence at a number of localities within the study area. Though formerly the most abundant ground squirrel in the region, this species was unexpectedly absent from all sandy prairie examined in the present study, except at Shilo and Carberry where two individuals were seen. The reason for the scarcity of this typical grassland species was not apparent, unless it avoided habitats on sand. It was very abundant in the mesic mixed-grass prairie and pastures on sandy loam at Oak Lake.

Spermophilus tridecemlineatus: Seton (1909) and Soper (1961) both reported decreasing numbers of thirteen-lined ground squirrels. Inhabitants of virgin prairie, their shallow burrows are destroyed by the plow so that they are now restricted to road-edges and unplowed fields. This species reached its greatest abundance in mesic prairie (37 on 2-hectare quadrat), but was still common on xeric and disturbed grasslands. Although avoiding forests, many tolerated savanna and dense shrubs as long as the grass stratum was dominant. Wet conditions were definitely avoided. Total, 65 specimens.

Spermophilus franklinii: in 1882, Seton (1909) described the Franklin ground squirrel as the rarest ground squirrel in southwestern Manitoba, but it then increased to three pairs per 100 yards along the wooded borders of the Assiniboine and Souris Rivers. Criddle (1929) found it to be common in the Treesbank area. During this study Franklin ground squirrels were very rare in sandy areas and only five individuals were taken, three on the Xeric Shrub Quadrat near a small maple tree, and two in saskatoon shrubs at Oak Lake. Total, 5 specimens.

Sciurus carolinensis: gray squirrels first invaded Manitoba in the Red River Valley in 1930 and reached Winnipeg in 1933 (Jackson 1940). The first specimen was taken at Holland in 1938 and by 1940 this species had reached Portage la Prairie. In 1946 it appeared at Treesbank where Criddle collected two specimens. In this study, one specimen was taken in an aspen–oak–ash forest on the east shore of Oak Lake, and others were observed in the riparian forest at Virden (western range extensions of about 60 miles). The Manitoba Museum recently received a specimen from 10 miles west of Ethelbert, and The Little Northern Museum at The Pas has two gray squirrels from Birch River (170 miles north of Virden) collected in 1961, which are new northern records. Additional specimens were secured at 1 mile north of Carberry (agricultural land, 0.5 miles from oak woods) and 5.5 miles west of St. Claude (aspen–oak–birch forest). The species is now common in woodlots and river-bottom forests throughout the study area, and it will probably continue to expand its range to the northern limits of bur oak. Total, 3 specimens.

Sciurus niger: one specimen of the fox squirrel (first Canadian record) was found at the edge of sandhills at a locality 5.5 miles west of St. Claude (Wrigley et al. 1973). The region consisted of numerous deciduous forest woodlots interspersed with crop and pasture land. The immediate site was oak–aspen savanna on the tops of sandhills, aspen–birch–basswood forest on mesic slopes, and willow shrubs in moist depressions. The area was searched for additional specimens but only gray and red squirrels were collected: the three arboreal squirrels were found in the same habitat. The fox squirrel probably invaded Manitoba from North Dakota and may have been resident in this region for many years. Total, 1 specimen.

Tamiasciurus hudsonicus: the red squirrel was found in all forest communities and extended out into spruce–oak–aspen and oak–aspen savanna. None was seen in spruce–aspen–juniper savanna (trees more widely spaced) or in aspen groves (isolated stands in open prairie), though red squirrels probably move through these habitats on occasion. Seton (1909) found this species in small oak groves surrounded by a half-mile of prairie at Carberry. Near the southern limit of its range (Souris River (Soper 1961)) the red squirrel is not restricted to coniferous or mixed forests, and is commonly observed, along with its grass tree-nests, in deciduous forests (particularly bur oak). Total, 11 specimens.

Glaucomys sabrinus: the only previous records of flying squirrels in this region were at Carberry (Seton 1909) and Treesbank (Criddle 1929). In the present study three specimens were taken on the Riparian Forest Quadrat in the Carberry Sandhills and three in the riparian forest on the Souris River, 3.8 miles north, 1 mile west of Margaret. Flying squirrels were also observed in similar habitat at Oak Lake. The latter two localities are range extensions of about 20 miles southwest and 45 miles west of Treesbank, respectively. Total, 6 specimens.

Thomomys talpoides: the northern pocket gopher was a consistent inhabitant of non-forested communities, reaching its greatest abundance in mesic prairie (21 on 2-hectare quadrat) but was also present in moist meadows, dry prairie (three on quadrat), and even

pioneer situations. It was abundant on the Xeric Shrub Quadrat (12 specimens) but only in the grass between the spaced silverberry shrubs, and not in the dense thickets of snowberry. Three were taken on the Mixed Savanna Quadrat and it was often common in savanna habitat at other localities. Two sets of mounds were observed in the Riparian Forest Quadrat but they were unoccupied. Total, 37 specimens plus hundreds of mound observations.

Perognathus fasciatus: Seton (1909) was unaware of the presence of olive-backed pocket mice in Manitoba, although Criddle (1929) reported this species as common in the Carberry Sandhills where Seton had studied for many years. Soper (1946) added records at Oak Lake and the junction of the Antler and Souris Rivers. Probably less than one dozen specimens from the three localities were known in the province before the present study. Pocket mice were found to be highly localized and rather uncommon. Since the species generally avoids traps, however, it must have been missed at many localities (only six taken in traps, 34 by hand). The mice emerged late in the evening when it was very dark, but one individual was still active two hours after sunrise. On July 6, 1972, 17 pocket mice (many immatures) were caught by hand within a 0.6-hectare (1.5-acre) area, a disturbed site in spruce–aspen–oak savanna. The species generally appeared to be attracted from adjacent mesic and xeric prairie and savanna to disturbed habitats (greater variety of seeds) along firebreaks, roadbanks, and grain fields. Five were found in pioneer communities on dunes and one individual on barren dunes. More accurate northern records for this species are specimens collected at 7.5 miles north, 1 mile east of Glenboro; 6 miles north, 1.3 miles west of Glenboro; and 6.5 miles south, 0.5 miles west of Oak Lake (town). Total, 40 specimens.

Castor canadensis: beaver abounded in every willow-fringed stream in southwestern Manitoba in the early 1800's, but were quickly trapped out and were unknown in the region in the 1880's (Seton 1909). They were extremely rare in the Treesbank area up to 1905, then became tolerably common (Criddle 1929). Soper (1946) stated that beaver occurred sparingly in the streams of the Carberry Sandhills, Turtle Mountains, and the Souris and Antler Rivers. In this study two individuals were observed in late afternoon feeding on sandbar willow along the shore of the Assiniboine River (north of Glenboro). Beaver cuttings were detected in the aspen–oak–birch forest of the Riparian Forest Quadrat, and a dam was located in the nearby creek. Fresh beaver sign was also seen in the shrubs and riparian forest on the Souris River north of Margaret, Pipestone Creek, Oak Lake, Plum Lake, and Plum Creek.

Peromyscus maniculatus: the deer mouse was the most abundant and ubiquitous mammal in the sandhills and plains. It was collected in every type of habitat except the tamarack swamp and barren dunes, and from evidence of numerous tracks it also traversed the latter. This species was able to withstand conditions that were cool and moist (33 individuals in Oak Lake marsh) to hot and arid, though by its nocturnal habits it would avoid the heat of day. Since it commonly occurred in communities ranging from forest to sand dunes, cover did not appear highly important in controlling local distribution. The deer mouse was overwhelmingly a species of disturbed sites (372 specimens found here) where it probably took advantage of the abundant and varied seed production of opportunistic plants. This was the only species captured on all five quadrats, though it was not abundant on any one. Disturbed habitats in the same region as each quadrat however, produced many specimens. For example, 400 mouse traps caught 82 deer mice in one night (along with 111 specimens of five other species) near a sandy road through mixed savanna in the Carberry Sandhills. Total, 640 specimens.

Onychomys leucogaster: the northern grasshopper mouse is a rare species in Manitoba, reaching its northeastern distributional limits in the Carberry Sandhills. Previously, less than one dozen specimens were known from only seven localities. Seton (1909) collected the first specimen in the Carberry Sandhills and Criddle (1929) added at least another six from open and partly wooded habitats, as well as one from a stubble field at Ninette. The Manitoba Museum has two specimens taken at Melita and Boissevain in sparse grassland on hillsides. Six specimens were collected in the present study, one in disturbed mesic prairie (edge of oats field at 6.5 miles south, 0.5 miles west of town of Oak Lake), four in disturbed xeric prairie (6 miles north, 1.3 miles west of Glenboro), and one in disturbed mixed savanna (7 miles north of Glenboro — a more definite peripheral record). The grasshopper mouse is similar to the deer mouse and pocket mouse in its predilection for disturbed sites. Total, 6 specimens.

Clethrionomys gapperi: the red-backed vole was consistently found in all habitats except xeric prairie, bare dunes, and unexpectedly, tamarack swamp and *Phragmites–Scholochloa* marsh. Although occasional individuals were present in grassland communities, including disturbed and pioneer sites, an association with woody cover was evident. The Riparian Forest and Xeric Shrub quadrats supported medium populations (17 voles on each), Mixed Savanna with an open cover of trees and shrubs only six, Mesic Prairie three, and Xeric Prairie none. Red-backed, meadow, and prairie voles were found together on three quadrats, but there appeared to be an inverse relationship in abundance between *Clethrionomys* and *Microtus* (Table 2). Total, 256 specimens.

Microtus pennsylvanicus: the meadow vole was found in habitats with a sedge or grass cover, and was

absent from forests as well as pioneer and bare dune areas. It preferred hydric and mesic communities and avoided xeric sites (xeric prairie, aspen–spruce–juniper savanna). Greatest numbers occurred in mesic prairie, meadows, and *Phragmites–Scholochloa* marsh. The presence of trees scattered in the grassland (savanna) did not appear to deter the voles, but a heavy growth of shrubs greatly decreased numbers. This was very evident from the quadrat results: the Mesic Prairie Quadrat produced 46 specimens while the nearby Xeric Shrub Quadrat had only one. Even the hydric shrub community was not attractive. Total, 202 specimens.

Microtus ochrogaster: the prairie vole favored mesic and xeric communities with short grassy cover, avoiding marsh and meadow where the meadow vole was dominant. The prairie vole was able to exploit xeric prairie and pioneer sites too arid and hot for the meadow vole (the grizzled-black prairie species was often active on sunny days in exposed, surface runways). Forests and dense shrubby growth in grassland were avoided, but savanna communities with scattered shrubs were optimum habitat, especially the tops and sides of sandhills. It was here that both species of *Microtus* were commonly found together, although the meadow vole was more prevalent in the valleys with thicker grass cover. While both species were common on the Mesic Prairie Quadrat, all 11 specimens of the prairie vole were restricted to the southwestern corner (the cover did not appear much sparser here), the meadow voles occupying the remainder of the quadrat. Minor range extensions in the north-central part of the range are specimens taken at 0.3 miles north, 5 miles west of St. Claude; 7 miles north of Glenboro; 2.7 miles south, 0.5 miles east of Shilo; and 0.5 miles north, 3.1 miles west of St. Lazare. Only several dozen specimens were previously known from Manitoba. Total, 127 specimens.

Ondatra zibethicus: muskrats were common in the marsh zone of ponds, lakes, and slow-running streams (Seton 1909; Criddle 1929; Soper 1946). Many were observed at Oak Lake and in the Souris River north of Margaret in this study. Bossenmaier (personal communication) reported interesting data on muskrat populations at Whitewater Lake. This shallow lake was almost dry during the 1930's and increased to 2–4 feet from 1941 to 1948. Several thousand acres were covered with a dense growth of cattail and bulrush, and muskrats became extremely numerous — in 1948 over 12,000 muskrats were harvested. A rise in the water level in 1949 destroyed most of the emergent vegetation and the muskrat population crashed. Local residents reported a mass exodus from the lake, during which time numerous animals appeared in farm yards and many others were killed along highways.

Mus musculus: four specimens of the introduced house mouse were collected under natural conditions, two near St. Lazare in xeric prairie and disturbed prairie (each over a mile from the nearest farm building), one in disturbed prairie at Hartney, and another in oak–aspen savanna at Portage la Prairie (both near farms). Seton (1909) noted the first appearance of this species in the Carberry area in 1886, locating several in a haystack. Criddle (1929) later found it to be abundant here in grain fields, returning to the shelter of buildings in winter. Total, 4 specimens.

Zapus hudsonius: the meadow jumping mouse was attracted to the early stages of the hydrosere, with the majority of specimens coming from hydric shrubs and meadows. Though two individuals were taken in xeric shrubs and xeric prairie, surprisingly none were found in mesic prairie. Their absence from the *Phragmites–Scholochloa* marsh at Oak Lake at the time of this study (September 18–19) was thought to be due to the onset of hibernation; there are previous records from here. The meadow jumping mouse accepted a variety of cover types: grass–sedge, shrub, swamp, forest, savanna. It was present on three quadrats, with nine in Riparian Forest and only one each in the progressively drier Mixed Savanna and Xeric Shrub. Oak Lake and the junction of the Souris and Antler Rivers are southwestern peripheral records (Soper 1946). Total, 41 specimens.

Zapus princeps: the western jumping mouse was not as common and widespread in the region as the meadow jumping mouse. It was previously known at only four localities in Manitoba (less than 10 specimens). In the present study 13 specimens were collected along the Souris River north of Margaret, one at 2.7 miles south, 0.5 miles east of Shilo, and another at 5.5 miles west of St. Claude. The latter locality extends the range 45 miles to the northeast from previous records at Treesbank (Criddle 1929) and Pembina River north of Mowbray (Soper 1961). Though there was considerable overlap in habitat utilization of the two jumping mice, the western species appeared able to withstand warmer and more arid conditions. Both species were taken together on the Xeric Shrub Quadrat and in the marsh–willow–meadow zones along the banks of the Souris River. None was taken well within forests, but it probably extends into forests if grass is present. The Shilo specimen was found just inside an aspen grove adjacent to the Xeric Prairie Quadrat, and the St. Claude specimen was under tumbleweed on sand dunes. Both sites were very dry with no standing water nearby. Total, 15 specimens.

Erethizon dorsatum: Seton (1909) did not find the porcupine as far southwest as the study area but Criddle (1929) later described it as rare in the spruce and aspen woods of the Carberry Sandhills. Soper (1961) reported an increase in numbers here around

1950, and added records from Lauder, Belmont, and Hargrave. I noted only six porcupines in the Carberry Sandhills in spruce–aspen–oak savanna and white spruce forest, and obtained two specimens. Bidlake (personal communication) reported their occurrence in many river-valley forests, and also in fields far from woods near Melita and Lyleton. Total, 2 specimens.

Canis latrans: Bidlake (personal communication) reported that coyotes were extremely numerous in some areas of southwestern Manitoba from 1971 to 1973, but that they would likely decrease with the recent crash of the snowshoe hare populations. Many hundreds were trapped in this region in the winter of 1972-1973. While I was working on the Mixed Savanna Quadrat at 10 a.m., several coyotes began calling at close range and many others were heard each night. Tracks, droppings, calls and a few observations revealed that this species hunted through almost all communities. The Manitoba Museum has one specimen from 5 miles north of Carberry.

Canis lupus: Seton (1909) reported that the gray wolf was common on the prairies of Manitoba until it almost disappeared after 1870 with the extirpation of bison. Criddle (1947) noted one specimen shot at Carberry in 1910 and observations of two adults and five pups in a den in the Carberry Sandhills in 1945. The Manitoba Museum has a specimen from this litter, and another from the junction of the Antler and Souris Rivers. At the present time the few wolves in the study region are restricted to the Spruce Woods Provincial Forest and Park within the Carberry Sandhills, although a larger number occur not far to the north in the Riding Mountains. Bidlake (personal communication) noted that the Spruce Woods population seldom exceeded six to eight animals, and that several had been destroyed recently because of stock predation.

Vulpes vulpes: the red fox was originally common in the marsh, prairie, and aspen poplar country of southwestern Manitoba (Seton 1909), but it was almost exterminated in the Carberry area in the early 1900's as a result of the bounty system on wolves and coyotes (Criddle 1929). Soper (1961) reported a marked increase in fox numbers by 1943 and periods of abundance since then. Hatch (personal communication) observed 43 animals in three days in February of 1965 while driving on the backroads around Oak Lake (farmland, woodlots, marsh), and Bidlake (personal communication) noted that populations were relatively high during the last three years (1971-1973) in many sandhill areas.

Vulpes velox: the swift fox was formerly present throughout southwestern Manitoba, and Seton (1909) described it as strictly a prairie animal, seldom venturing far from its burrows. In the season of 1804–1805, 57 pelts were obtained by trader Alexander Henry from the Souris River and Pembina Hills (northeastern edge of the range). Seton believed that this species rapidly disappeared from the province because of its unsuspicious nature and consequent easy poisoning by coyote bait.

Ursus americanus: Seton (1909) reported that black bears were of general occurrence in the aspen poplar belt of this region, and told of two young bears (one cinnamon, one black) that were found in a den at Carberry in 1895. On two occasions he approached bears closely on the open plains. In the early 1900's this species became very rare, with only a few individuals present in the tamarack swamp of the Spruce Woods Forest east of Shilo and along the Assiniboine River (Criddle 1929). The black bear is presently exterminated from the whole region, though a few individuals may occasionally wander into the area from the Riding Mountains.

Ursus horribilis: the grizzly bear was apparently not uncommon on the plains of southern Manitoba in the early 1800's, as recorded by Alexander Henry (see Seton 1909). A number were collected from Portage la Prairie, Pembina River, Pembina Mountains, and the Red and Roseau Rivers (eastern limits of the range). These records gain further credibility by the existence in the Manitoba Museum of a grizzly skull, which was ploughed up in a field at Austin (23 miles west of Portage la Prairie).

Procyon lotor: the racoon was reported by Seton (1909) as exceedingly rare in southwestern Manitoba in the early 1900's with a few records along the Souris River and near Brandon and Treesbank on the Assiniboine River. Criddle (1929) noted only three individuals along the Assiniboine River in the Carberry Sandhills. Since then this species has become common in river-valley forests and marshes throughout the region and has spread north to many locations in the southern half of the province.

Martes americana: the marten is a boreal forest species barely reaching as far south as the study region. During the 1800's it was very rare in the Pembina Hills, and there was only a single record from the spruce forests of the Carberry Sandhills. Criddle (1929) noted an additional record here in 1910.

Mustela erminea: Seton (1909) and Criddle (1929) described the short-tailed weasel as common in the Carberry Sandhills. This species is still found in marshes, prairie, and woodlots, except in the extreme southwestern corner of the province (southwestern boundary of the species).

Mustela nivalis: the least weasel was reported as tolerably common in meadows (Criddle 1929) and rare in wooded stream valleys and cultivated fields (Soper 1961). The Manitoba Museum has specimens

from Lyleton and Oak Lake, and during this study another individual was caught in a mousetrap set across a meadow-mouse runway in marsh vegetation at Oak Lake. Total, 1 specimen.

Mustela frenata: Seton (1909) found the long-tailed weasel abundant on the prairies of Manitoba (northern periphery of its range), preferring the cover of thickets, riverbanks, and disturbed areas, and although not in woods, seldom more than a mile away. Criddle (1929) reported it as common in the Carberry Sandhills and Soper (1961) noted its occurrence most often on the treeless prairies, but occasionally in aspen groveland and mixed forests (records at Portage la Prairie, Carberry, Treesbank, and Pipestone). During this study one specimen was collected at Oak Lake in marsh–meadow habitat, and another was observed in farmland at Killarney. Total, 1 specimen.

Mustela vison: Seton (1909) reported mink throughout the prairie region, usually along sloughs, and observed many individuals in the Carberry Sandhills where Criddle (1929) later found it tolerably common. In the present investigation two specimens were obtained from a marsh at Souris, and it was relatively common at Oak Lake marsh. Total, 2 specimens.

Gulo luscus: the wolverine is an inhabitant of boreal forest and arctic tundra but it occurred in the past as far south as North Dakota and Minnesota (Hall and Kelson 1959). The inclusion of the wolverine in the study region is on a geographical basis only, since there are no definite records of its occurring here.

Taxidea taxus: Seton (1909) thought there was at least one badger per square mile on the rolling dry prairies of southern Manitoba, and it is still common in the study area. The Manitoba Museum has specimens from Minto, Melita, and Oak Lake, and badgers were observed at Oak Lake, Miniota, Lyleton, and the Lauder Sandhills.

Mephitis mephitis: the striped skunk was reported by Seton (1909) to be particularly abundant (one per square mile) along the edges of woods and marshes. Criddle (1929) found it common but fluctuating in numbers in the Carberry Sandhills, and Soper (1961), most numerous in the aspen-oak belt. Populations of skunks have been very high recently and hundreds of road-kills were seen in areas adjacent to farmland, prairie, marsh, and aspen–oak woods.

Lutra canadensis: the river otter was formerly common in the large streams and rivers of this region but it became very rare in the 1800's as a result of trapping (Seton 1909). Only a few were thought to remain in Epinette Creek in the Carberry Sandhills in the early 1900's (Criddle 1929), and it now appears to be exterminated from the whole area.

Felis concolor: Seton (1925) reported cougar from 1892 to 1905 at Makinak, Oak Lake, Brandon, Swan Lake, Plum Coulee, and Elphinstone. Soper (1961) added records at Riding and Turtle Mountains, Marquette, and a note of a cougar attacking two children (killing one) at Birtle in 1922. When shot, the animal was found to be blind and starved. Other reports from the Manitoba Museum files from southwestern Manitoba are Pembina Hills (specimen shot in 1879), Hartney (1907), Nesbitt (1961), 10 miles south of Minnedosa (1964), and 8 miles east of Souris (1968). A recently published report was from the Antler area on the Saskatchewan–Manitoba border, 40 miles north of the North Dakota border (White 1973). Bidlake (personal communication) receives at least one unconfirmed cougar report annually from the study region, usually in regard to cattle predation. Until more concrete evidence becomes available, the present status of the cougar in this area must remain hypothetical. However, there is no doubt that this species occurs in adjacent areas in Manitoba; the Manitoba Museum recently received an adult male cougar collected on December 25, 1973 at a locality 30 miles north and 30 miles east of Winnipeg.

Lynx canadensis: the lynx was reported as rare in the Carberry Sandhills in the late 1800's by Seton (1909), and Criddle (1929) noted only an occasional animal wandering this far south in search of snowshoe hares. Hatch (personal communication) noticed that lynx appeared in good numbers around Oak Lake during 1961 and 1962, but decreased steadily until the last was seen in 1968.

Lynx rufus: Seton (1925) noted two bobcat records just east of the study area from La Riviere and Pembina, and one to the west at Whitewood, Saskatchewan (northern edge of range). Criddle (1929) reported one specimen collected in a tamarack swamp in the Carberry Sandhills in 1908. Shoesmith (personal communication) observed a bobcat in 1971 at a locality 11 miles southwest of Souris.

Cervus canadensis: elk were formerly common throughout southwestern Manitoba but were almost exterminated during the 1800's. Seton (1909) mentioned that an elk was shot in the Carberry Sandhills in 1857, and although he found numerous antlers, only one individual was observed by him, in 1884. Criddle (1929) noted that this species was tolerably common in the Carberry area until 1887 when it disappeared from the district. Recent aerial survey data made available by Bossenmaier revealed that elk reinvaded the Spruce Woods Forest and Park as follows: 1958, 2 elk; 1959, 0; 1960, 15; 1961, 35; 1962, 58; 1963, 63. About the year 1960, there was a reliable report of 13 elk moving from the Riding Mountains in the direction of the Spruce Woods Forest. Bidlake (personal communication) reported that the Spruce Woods herd now numbers about 150

animals. The majority winter in the willow growth along Epinette Creek, and trails are worn through savanna and grassland in many areas. Individuals from this herd, as well as from the Riding Mountains, stray along wooded river valleys and have been sighted at Souris, Oak Lake, and the Turtle Mountains. The Manitoba Museum has one specimen from the Spruce Woods herd.

Odocoileus hemionus: the mule deer formerly occurred as far northeast as southwestern Manitoba where it frequented the groveland belt and extended into mixed forests to the north (Soper 1961). Seton (1909) reported that this species was already becoming scarce in the Carberry Sandhills in the late 1800's owing to excessive hunting, but with greater protection, numbers increased in the early 1900's. Criddle (1929) also found mule deer throughout the sand dune country but by the 1920's they were again rare, with only a few individuals persisting in the area north of Glenboro. Since then populations of mule deer have steadily declined until in the 1950's only small herds remained in the Spruce Woods region (14 individuals), and the Riding and Duck Mountains (Soper 1961). Bidlake (personal communication) noted recent reports from Killarney, Melita, Dauphin, and Steinbach, and possibly small herds in Riding and Duck Mountains. The status of this species is presently uncertain in Manitoba and its continued existence here seems doubtful.

Odocoileus virginianus: the white-tailed deer did not occur in Manitoba until around 1881, following settlement of the region north of its original range (Seton 1909). Criddle (1929) found it to be common in the Carberry Sandhills in the early 1900's. With excellent habitat vacated by mule deer, white-tailed deer increased rapidly, and they were so abundant by 1948 that Soper (1961) counted 122 animals in the 18 miles of hilly grassland between Brandon and Rivers, with many more probably hidden in the scattered aspen bluffs. Though deer tracks, beds, browsing sign, and droppings were noted at many localities during this study, deer were observed on only three occasions. On 25 March 1971, seven deer were disturbed while bedded down in a tangle of spruce and juniper in the Bald Head Hills south of Carberry. Another was hidden in thick willow growth on the edge of the Riparian Forest Quadrat, and a third walked through the Xeric Shrub and Mesic Prairie Quadrats on its way to the Souris River. Bidlake (personal communication), who has conducted aerial surveys over much of the sandhill country, related that sandhill communities were key wintering areas for white-tailed deer, with densities up to 20 per square mile in the Lauder Sandhills, (southwest of Hartney), 2 to 5 in the Spruce Woods region, 5 to 10 in the St. Lazare area, and less than 1 per square mile in the Portage la Prairie Sandhills (low owing to excessive harvest). This species has completely replaced the mule deer as the common deer of southern Manitoba.

Alces alces: a small number of moose was reported in the tamarack swamp in the northern part of the Spruce Woods Forest in the late 1800's by Seton (1909), and others occurred in deciduous forests of the Turtle Mountains (southern edge of the range), and the Pembina and Tiger Hills (Soper 1946). The Spruce Woods herd of 30 to 60 animals has persisted in the Epinette Creek area and occasional individuals wander south to the Turtle Mountains (Bidlake reported three in 1973). Stray moose from the Spruce Woods or Riding Mountain herd have appeared in the Souris and Oak Lake regions.

Rangifer tarandus: Bailey (1926) reported that antler fragments of woodland caribou were found in the Turtle Mountains in North Dakota, and on the basis of this record Soper (1961) stated that this species had doubtless inhabited the heights of Riding and Duck Mountains. The confirmed caribou reports closest to the study area are from the Porcupine Mountains to the north and Whiteshell Provincial Park in southeastern Manitoba. The complete lack of early records in southwestern Manitoba, as well as the absence of preferred habitat, suggest that caribou were not regular inhabitants of this region and at most only minor migrations of individuals occurred this far south of the boreal forest.

Antilocapra americana: the pronghorn abounded on the prairies of southwestern Manitoba, extending as far north as Carberry and the Minnedosa River, and east to the Red River, but it was wiped out by 1882. Greatest numbers and the last bands were located in the Brandon Hills and the Souris Plains (Seton 1909). Bidlake (personal communication) reported that in 1972 a few individuals wandered into the study area from North Dakota or Saskatchewan, and were observed at Pilot Mound, Boissevain, and Lyleton.

Bison bison: The decline of the bison in southwestern Manitoba was traced through old accounts by Seton (1909): the area west of the Red River was "overrun" around 1800, a large herd in the Carberry Sandhills was decimated by buffalo hunters in 1852, the last large herd covered the site of present-day Brandon in 1861, and the last individual (an old bull) was observed in 1883 crossing the Souris Plains between Boissevain and Souris.

Summary and Conclusions

The sandhills and plains of extreme southwestern Manitoba have supported within historical times a total of 63 species of mammals, two-thirds of which reach their limits of distribution in or near this region. Thirty-six percent

of the mammalian fauna is composed of wide-ranging species, 30% is characteristic of the Coniferous Forest Biome, 19% of the Grassland Biome, 13% of the Temperate Deciduous Forest Biome, and 2% introduced. The white-tailed jack rabbit, eastern cottontail, gray squirrel, fox squirrel, raccoon, and white-tailed deer have expanded their ranges into Manitoba within the last 100 years. After having been exterminated from the province, a few pronghorns have now reappeared. New range extensions are reported for the Keen bat, big brown

TABLE 3. — Derivation of the mammalian fauna of southwestern Manitoba

CONIFEROUS FOREST BIOME 30%

Masked shrew
*Water shrew
*Arctic shrew
*Pygmy shrew
Snowshoe hare
*Least chipmunk
*Red squirrel
*Northern flying squirrel
Red-backed vole
Meadow vole
*Meadow jumping mouse
*Western jumping mouse
*Marten
*Short-tailed weasel
Least weasel
*Wolverine
Lynx
*Moose
*Caribou

GRASSLAND BIOME 19%

*White-tailed jack rabbit
*Richardson ground squirrel
*Thirteen-lined ground squirrel
*Franklin ground squirrel
*Northern Pocket gopher
*Olive-backed pocket mouse
*Northern grasshopper mouse
*Prairie vole
*Swift fox
*Badger
*Pronghorn
*Bison

INTRODUCED 2%

House mouse

DECIDUOUS FOREST BIOME 13%

*Short-tailed shrew
*Keen bat
*Red bat
*Eastern cottontail
*Eastern chipmunk
*Woodchuck
*Gray squirrel
*Fox squirrel

WIDESPREAD 36%

Little brown bat
*Silver-haired bat
*Big brown bat
Hoary bat
Beaver
Deer mouse
Muskrat
Porcupine
Coyote
Gray wolf
Red fox
Black bear
*Grizzly bear
*Raccoon
*Long-tailed weasel
Mink
Striped skunk
River otter
*Cougar
*Bobcat
Elk
*Mule deer
*White-tailed deer

Total species, 63
Marginal species, 67%

*Species which reach their distributional limits within or near the study region.

bat, gray squirrel, fox squirrel, northern flying squirrel, olive-backed pocket mouse, northern grasshopper mouse, prairie vole, western jumping mouse, and cougar.

The numerous plant communities are arranged in series illustrating several climaxes and probable hydroseres and xeroseres. The zonation of mammals (in particular the Insectivora, Lagomorpha, and Rodentia) is described within these communities, from which one may predict changes in the fauna as a result of floral succession and disturbance. While certain species are ubiquitous (e.g., deer mouse, masked shrew, red-backed vole), others are restricted to very definite habitats (e.g., muskrat, woodchuck, Franklin ground squirrel). The total ecological amplitude of species occurring here is such that all habitats from open water (water shrew) to barren dunes (pocket mouse) are exploited, including aerial (bats), tree (red squirrel), shrub (chipmunks), herb (mice), litter (shrews), and soil (pocket gopher) strata. Edaphic and climatic factors influence a zonation of diverse plant communities between the valleys and peaks of sand dunes, and consequently species of mammals with very different habitat requirements are found in close proximity (e.g., water shrew, eastern chipmunk, and olive-backed pocket mouse).

The number of species and individuals, respectively, present on the 2-hectare quadrats were: Riparian Forest, 14 (65); Mixed Savanna, 15 (39); Xeric Shrub, 13 (100); Mesic Prairie, 9 (142); Xeric Prairie, 4 (17). The lack of tree and shrub strata is partly responsible for the decrease in species on the two prairie quadrats, while edaphic factors (low soil moisture, lack of developed humus and litter layers on sand), temperature extremes, and sparse cover of vegetation account for the absence of all but four species on the Xeric Prairie Quadrat. The low number of individuals on the Mixed Savanna Quadrat is due mostly to the lack of recruitment of young to the populations in early June, but the few specimens taken on the Xeric Prairie Quadrat in July are thought to be the result of low carrying capacity of this relatively harsh environment.

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Distribution and Numbers of White-tailed Deer Wintering in Gatineau Park, Quebec

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Miller, F. L. 1974. Distribution and numbers of white-tailed deer wintering in Gatineau Park, Quebec. Canadian Field-Naturalist 88: 41-45.

Abstract. Helicopter surveys of white-tailed deer (*Odocoileus virginianus*) wintering within Gatineau Park, Quebec, were carried out on January 20 and March 6, 1971; January 24 and March 25, 1972; and February 17, 1973. Totals of 53 and 64 deer were seen during the two January surveys, 144 and 159 during the two March surveys, and 209 during the February survey. The surveys in March 1971, March 1972, and February 1973 indicate a marked increase in deer wintering on the Eardley Escarpment: yearly increase of about 33% and an overall increase of 78%. Observed numbers of deer within the interior of the park remained relatively constant, except in March 1971, but are subject to much observational error because of the dense canopy. The variation between early and late winter surveys indicated that deer continued to move to the escarpment as winter progressed. The combined aerial and ground surveys in March 1971 and 1972 and the February 1973 aerial survey suggested that 250–300 deer wintered within the park and that the number of deer within the park may have been on the upward trend. Management of the deer and the vegetation on the Eardley Escarpment probably will be necessary to maintain high numbers of deer during winter on a sustained basis.

Introduction

National Capital Commission personnel responsible for Gatineau Park, Quebec requested the Canadian Wildlife Service to obtain information on the distribution and number of white-tailed deer (*Odocoileus virginianus*) wintering within the park. Aerial surveys for this purpose were conducted during the winter months when obstruction of view by the forest canopy is minimal. Snow cover also provided maximal background contrast. Five aerial helicopter surveys were made to provide the required estimates.

Although deer have access to and egress from Gatineau Park during all seasons of the year, information from residents of the area suggests that deer have had long-term affinities for specific wintering areas within the park. The only two previous estimates based on aerial surveys of deer wintering in the Gatineau Park were reported by Baker (1970): 165 deer in December 1968 and 152 deer in January 1970. In his surveys, total deer numbers were estimated as the sum of all observations of deer, plus isolated deer trails.

Gatineau Park is a federally administered area located about 10 miles northwest of Ottawa, in Quebec. The park is mostly forested with conifers and hardwoods occurring in pure and mixed stands. The topography within the park is generally of a broken glaciated type with many rock outcrops. The most prominent land feature is the Eardley Escarpment, rising to 1,000 feet, along the south boundary of the park. The major wintering areas of deer within the park were described by Baker (1970). A general description of the park's flora and fauna was given by the National and Provincial Parks Association of Canada (1972).

Methods

Random survey methods could not be developed because of limited operating funds. A non-random 150-mile survey flight-path was chosen to include as many probable deer wintering areas as possible for the 1971 and 1972 surveys. The flight course was based mainly on Baker's (1970) delineation of deer wintering areas within the park. The four surveys were made on January 20, March 6, 1971; January 24, March 25, 1972. Each survey required about three hours. The amount of circling and hovering during each survey differed and influenced overall time requirements.

The February 17, 1973 survey was flown along 220 miles of north–south transect lines, 1 mile apart, from the west end eastward to the ski and residential area of the park. The transect lines were often altered slightly to include lake shores and knolls of ground that were considered likely deer wintering habitat. The survey required 4.5 hours. Coverage within the interior of the park (150 line-miles) was double that of previous surveys, but coverage on the escarpment (70 miles) was the same as in the previous four surveys. All surveys were flown in a Hiller 12E helicopter.

Two observers and one pilot-observer were used on each survey. Altitudes maintained during the survey flight varied in accordance with the type of cover and terrain. Maximal altitude was about 300 feet above treetops. All deer and sign of deer were recorded on 1:50,000 scale maps of the park (MCR216, Canada Department of Energy, Mines and Resources, Ottawa).

Ground counts of deer during the survey period were made by Gatineau Park wardens to supplement the aerial counts in March 1971 and 1972. The ground surveys were conducted as non-systematic patrols throughout the park. Most areas of suspected deer use were searched.

Results and Discussion

Twenty sites were used by deer during one or more of the five survey periods (Figure 1). Conditions along much of the escarpment are good for observing deer because of the relatively open mixed-hardwood character and steep south slopes which allow many observations to be made at the sides rather than just below the aircraft. Expectation of concentrations of deer at known supplemental feeding areas (Wintering sites 13 and 18 of Figure 1 and Table 1) also enhanced the count. The dense coniferous cover of the wintering areas in the interior of the park, however, greatly hindered observations of deer. Resultant counts from the park interior most likely represented only a small fraction of the deer wintering there. This supposition is further supported by ground counts of deer on interior sites during March 1971 and 1972.

Only five deer were seen at new locations during the February 1973 survey but trails of deer were seen at 26 new sites. All new aerial observations corresponded with information previously obtained from ground counts of deer in March 1971 and 1972. None of the new sites was considered as a winter "yarding" area for deer. Many wooded portions of the drain-

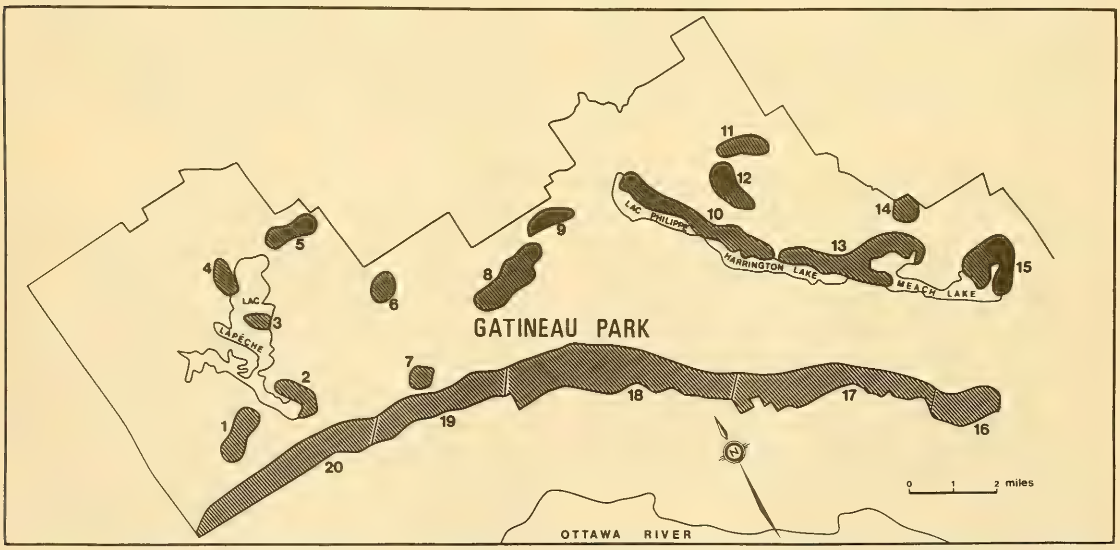

FIGURE 1. Locations of major deer wintering areas within Gatineau Park, Quebec, 1971–1973.

ages flowing into the Ottawa River south of the park boundary were also occupied by deer during the surveys.

The numbers of deer observed during the two January surveys (Table 1) were similar and low, apparently because all deer had not moved to their wintering areas. The variations in the use of wintering sites during January 1971 and 1972 most likely reflect yearly differences in the dispersal of the deer. Most of the highly productive winter browsing areas are on interior park sites (Baker 1970). Evidently the deer remain dispersed, as long as movement between cover and forage is unrestricted by snow cover.

When the snow depth approaches 20 inches (Taylor 1956), and is not dense enough to support deer, the situation becomes critical. Most deer then move to the less productive but traversable sites on the escarpment. The

TABLE 1. — Deer numbers and sign by wintering sites as determined by helicopter surveys in Gatineau Park, Quebec

Deer wintering sites	Dates of aerial surveys				
	Jan. 20 1971	Jan. 24 1972	Mar. 6 1971	Mar. 25 1972	Feb. 17 1973
Interior areas					
1	T[a]	1	T	T	2
2	4	1	T	T	2
3	NS[b]	T	T	T	T
4	NS	T	T	T	T
5	NS	T	T	NS	T
6	3	T	T	NS	T
7	T	3	T	NS	T
8	5	4	13	NS	T
9	T	T	T	NS	T
10	4	T	T	NS	T
11	T	1	T	T	T
12	NS	1	2	4	T
13	T[c]	3[c]	12	15	9
14	NS	4	T	T	1
15	T	4	13	1	5
Interior sub-total	16	22	40	20	19[e]
Escarpment areas					
16	T	2	4	3	12
17	9	6	13	21	59
18	25[d]	18[d]	72[d]	68[d]	91[d]
19	3	11	15	35	14
20	T	5	T	12	9
Escarpment sub-total	37	42	104	139	185
Survey line total	53	64	144	159	204[e]

[a]T = trails that suggested deer wintering area.
[b]NS = no deer sign during the survey period.
[c]Many trails radiating out from supplemental deer feeding-station.
[d]Most of the deer sighted in this area were using the supplemental feeding-station at J. Archambault's farm.
[e]Five deer seen on three interior park sites are not listed in this table.

uncertainty of the dispersal of park deer in early winter, therefore, reduces the value of January surveys.

The total numbers of deer seen during the March surveys were also similar (Table 1). The reduction in the number of sites where deer wintered within the park interior in 1972 (Table 1) most likely reflects the relative ease of travel by deer in March 1971. The rain of late February 1971 and the slight thawing and refreezing of snow during March 1971 produced snow-layering that supported deer walking at a deliberate pace. On the areas examined deer were often sinking only 10 to 15 inches. The nature of the snow allowed deer to move about and obtain browse at higher levels on the trees and shrubs. Trails in the interior of the park indicated that many deer had not moved to the escarpment but were occupying scattered small yards.

Snow conditions during the March 1972 survey period were not favorable for deer movements. Probably many of the deer that had been wintering on interior park sites moved to the escarpment during midwinter in response to the high snow accumulation. The number of deer observed on the escarpment had increased about 33% over the number seen in March 1971.

The March 1972 survey was carried out about 24 hours after 10 inches of snow had fallen. The survey took place between 1100 and 1530 hours under dull sunlight with temperatures (°F) in the mid-twenties. More observed deer were bedded during this survey than during any other. Of the 159 deer observed, 103 (65%) were bedded. Eighty-seven (85%) of the bedded deer remained bedded after having been flown over once. Fifty-two percent (45) of the deer that remained bedded did not move off after the helicopter repeatedly circled and hovered over them. The limited response by the deer to the helicopter in the March 1972 survey, in contrast to that of other surveys, was probably related to environmental stimuli and energy balance. Such variations in the response to aircraft could have influenced total counts during the various surveys.

Supplemental information from the March 1971 and 1972 ground counts by park wardens suggested that an estimate of about 100 deer more than observed by aerial survey would be conservative. Time lapses between aerial and ground counts, and the locations of many deer reduced the accuracy of aerial and ground separations. Most ground counts of deer on areas also surveyed by air were about 50% lower than the number seen from aircraft.

The February 1973 survey results indicated a marked increase in deer wintering on the escarpment: 33% from March 1972 and 78% from March 1971. The number of deer (24) observed within the interior of the park had not increased over that from previous surveys despite increased coverage. Travel conditions for deer during 1973 were most favorable. Multi-deer trails and tracks of lone deer indicated that almost the entire area from the north shore of Harrington Lake to the northern boundary of the park was being used by deer. The northeast-facing slopes beyond the park boundary showed signs of heavy deer-occupation. My observations during February 1973 showed that deer were able to traverse most, if not all, of the park interior. Yet, most deer sought out, and remained on, the relatively vegetation-poor sites of the Eardley Escarpment.

February–March is the time of maximal concentrations of deer within Gatineau Park. The deer are most easily seen on the escarpment and the lowlands below and south of the escarpment. Therefore, that period is the best for aerial surveys of deer wintering within the park. Considerable winter loss or deterioration of deer could occur between mid-February and late March. Therefore, late March surveys should provide better estimates of numbers of deer surviving periods characteristic of winter. Although the period of stress for deer often continues far into the spring, snow cover in April is too variable for reliable survey conditions from year to year.

A continuation of aerial surveys in March, supplemented by simultaneous ground surveys, would provide both a maximal estimate of deer wintering within the park and an indication of

any trend in the use of wintering sites by deer. The combined March aerial and ground counts and the February aerial survey suggests that there are 250–300 deer currently wintering within Gatineau Park.

From my 1973 observations I must conclude that most of the deer wintering within Gatineau Park have learned to use the Eardley Escarpment as a wintering area regardless of existing snow conditions. Therefore, protection and possibly management of the deer and vegetation on the escarpment are necessary for sustaining a high number of deer within the park. Extension of the southern boundary of the park or leasing of certain lands south of the park would enhance the possibility of maintaining a high number of deer and provide a better potential for their proper management.

The 12 square miles of escarpment and lowlands between the Masham-Eardley Road and Luskville Falls is currently the area of primary importance. The ultimate goal should be public enjoyment of this resource, that is the greatest possible opportunity for seeing deer.

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The Collection of Bryophytes in the Fowler Herbarium, Queen's University, Kingston, Ontario

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Crowder, A. A. 1974. The collection of bryophytes in the Fowler Herbarum, Queen's University, Kingston, Ontario. Canadian Field-Naturalist 88: 47-55.

Abstract. The history of the build-up of the bryophyte collection (to over 7000 specimens) in the Fowler Herbarium is outlined. Several specimens were collected in the nineteenth century. Most of the plants of historical interest are available to visitors.

The herbarium at Queen's University in Kingston, Ontario, contains a small collection of mosses and liverworts, which were recently sorted and catalogued. While this was being done it became necessary to make a card index of collectors and localities, because many of the specimens were not completely labelled, but had initials or partial information which could be filled in from the index. The reception of a brief paper read to the Canadian Botanical Association indicated that the publication of a history of the collection could be helpful to other herbaria possessing similar old specimens of uncertain provenance. Unfortunately, little correspondence survived the moves which the bryophytes, together with the rest of the collection, experienced before being housed in Earl Hall in 1966. Dr. R. E. Beschel wrote a history of the Fowler Herbarium for the occasion of the opening of Earl Hall (Beschel 1966).

The basis of the moss collection is a set of some 60 mosses collected in the British Isles mostly in the 1830's, although the earliest had been mounted in 1824. Most of them are English — from Exmouth, Richmond, and Clifton — several are the result of a visit to Cleish in Fifeshire in 1832, one is from northern Wales. When collecting in Ireland the bryologist showed a romantic taste, visiting Muckross Abbey and Killarney (Figure 1A shows one of the labels). The identity of the collector is not clear, some of the specimens have a later Fowler label on them, and on three is the inscription "Mr. Wilson." The English bryologist William Wilson[1] lived from 1799 to 1871, and so could have been a correspondent of Fowler, who was born in 1829. Wilson's major work was published in 1855.

The Reverend James Fowler was appointed, firstly as a lecturer, to a position teaching natural science at Queen's in 1880 (Beschel 1966), and until retirement in 1907 he added to the herbarium which is now named in his honor. Most of the 400 mosses come from his earlier collections, in the Maritimes, but after his appointment he collected in Ontario and British Columbia. Figures 1B, 1C, 3A–D show labels used by Fowler.

Before Fowler's arrival the herbarium had been started by Professor George Lawson, (Rousseau and Dore 1966) and the mosses he collected date from 1858–1859 (See Figures 1B, C). They were collected within a day's ride of Kingston, or along the Rideau Canal. Lawson left behind him in Kingston a flourishing Botanical Society with members in correspondence with collectors throughout the world, and a botanic garden which later became a lawn (Dore 1967). Just as the public buildings of Kingston are a reminder of the city's past glories, the herbarium survived and contains specimens collected by the early members of the Botanical Society.

[1]The birth and death dates of most bryologists may be found in Sayre et al. (1964).

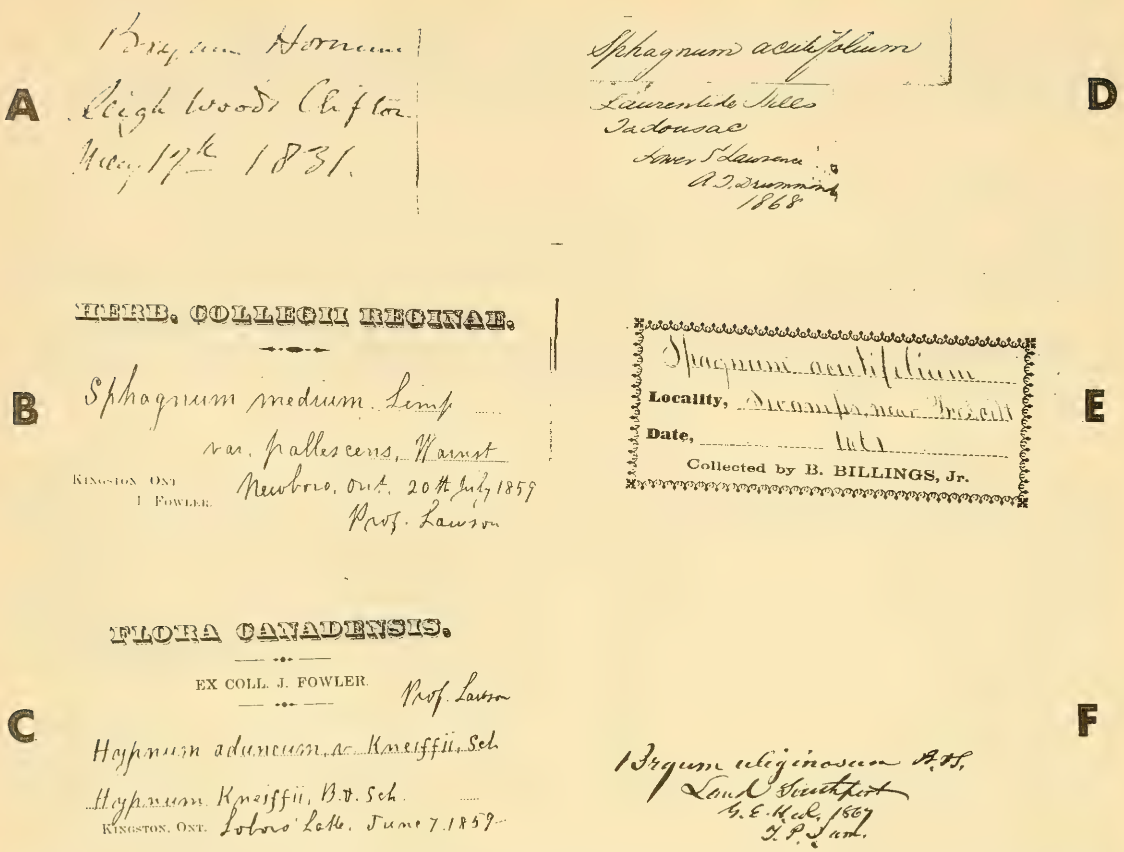

FIGURE 1. A. An example of the labels of the British collection made in 1824–1832, possibly attributable to Wilson. B. and C. Labels of mosses collected by Lawson near Kingston in 1859, incorporated in Fowler's collection. D. An example of Drummond's collection made at Tadousac. E. Billings' elegant label dates from 1861. F. The label of a moss collected in England by G. E. Hunt, and exchanged by T. P. James. Photographs by Neil Carter.

Professor John Macoun was perhaps the most eminent member; he had taught at Albert College in Belleville, Ontario, and was about to move to Ottawa at the time of Fowler's appointment, as he had obtained a permanent post in the Geological and Natural History Survey (Macoun 1922). The mosses he collected from Belleville are from the Bay of Quinte, and what was then largely bush country in the north of Hastings County. There are only 180 mosses attributed to Macoun, but there are just as many without a collector's name which must have come from his widening travels (See Figure 2C). He was a member of the Sandford Fleming survey party for the railway, and the mosses come from its route past Lake Superior to Vancouver. The difficulties of collecting a century ago are indicated by his recipe for a fly repellent — tar and castor oil rubbed onto the skin and left for a week. After 1870, he seldom combined information about collector, locality, and date on one label, and in 1881 he rather oddly used a printed label headed *Queen's College, Kingston,* and subtitled *Ex. Herb. J. Macoun* which is shown in Figure 2D. After he moved to Ottawa he collected some mosses in Quebec for a flora of Ottawa. Macoun seems to have been cordial to Lawson, but hardly mentions Fowler in his autobiography although they exchanged speci-

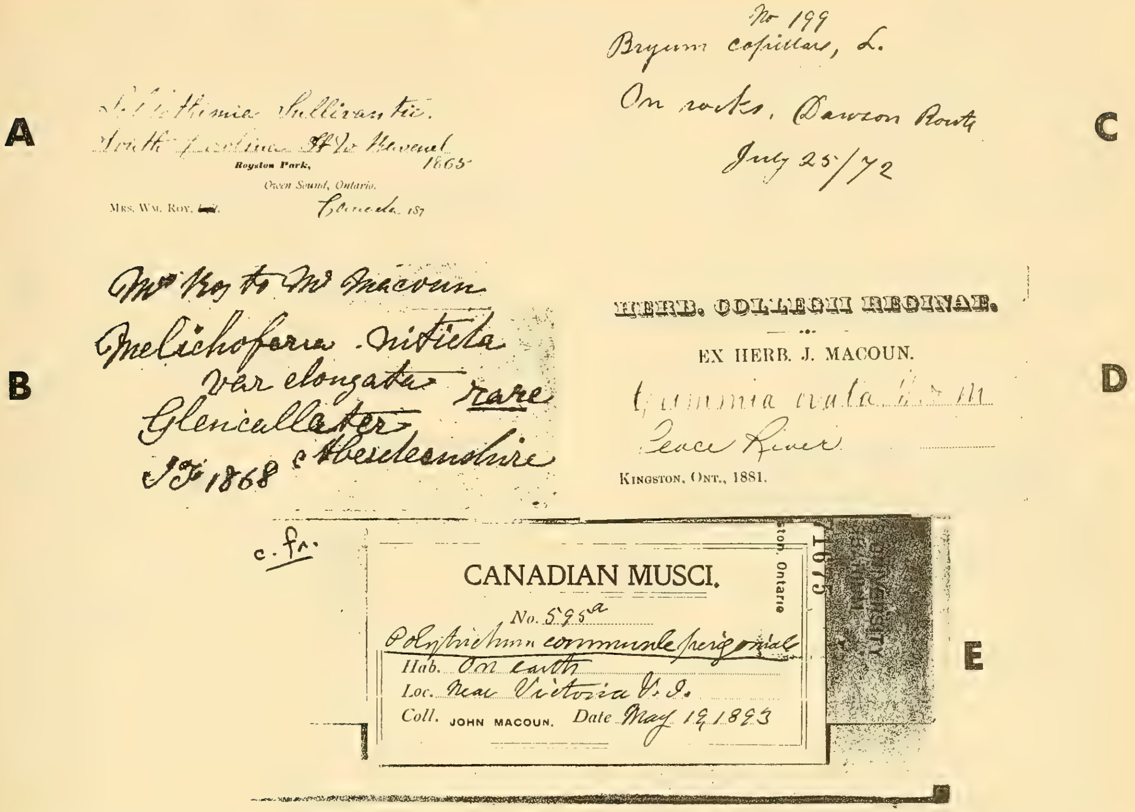

FIGURE 2. A. Mrs. Roy's label. B. A specimen collected in Scotland by the Reverend Ian Ferguson, sent to Macoun by Mrs. Roy. C–E. Macoun's labels: C is an early collection without his name; D is an example of the 1881 labels linking him to Queen's College Herbarium; and E is a label used after he had joined the Geological Survey. Photographs by Neil Carter.

mens. Macoun sent specimens which he wished to have checked to C. F. Austin and T. P. James in the United States, and later to N. C. Kindberg in Sweden and C. Müller in Germany. In 1880–1881 the Geological Survey acquired most of his plant collection, but he retained the mosses which he sold in sets (Macoun 1922).

Other Botanical Society members who collected mosses were Dr. R. Bell, Dr. A. Drummond, and B. Billings. Drummond's carefully annotated specimens come from London and Rice Lake in Ontario, and Tadousac in Quebec (Figure 1D). Billings lived at Prescott and collected in the St. Lawrence valley; like most amateurs of the time he had elegantly printed personal labels (Figure 1E). Dr. Bell taught at Queen's and worked for the Geological Survey; most of his field work was in northern Ontario and Manitoba (Figure 3E).

Another notable amateur of this time was Mrs. William Roy (only Austin refers to her as Jessie), who lived at Royston Park, near Owen Sound. She exchanged specimens with Macoun and Fowler, and her records were used by Macoun (1883–1902), Austin (1870), and Lesquereux and James (1884). Her labels are very businesslike, with no decorative scrolls or borders (see Figure 2A), but unfortunately her writing resembles Macoun's, so that it is sometimes impossible to know which one of them wrote the label. In 1871 Macoun visited the Roys and wrote ". . . July of that year saw me a guest at Royston Park, and for the first time having communion with a botanist day

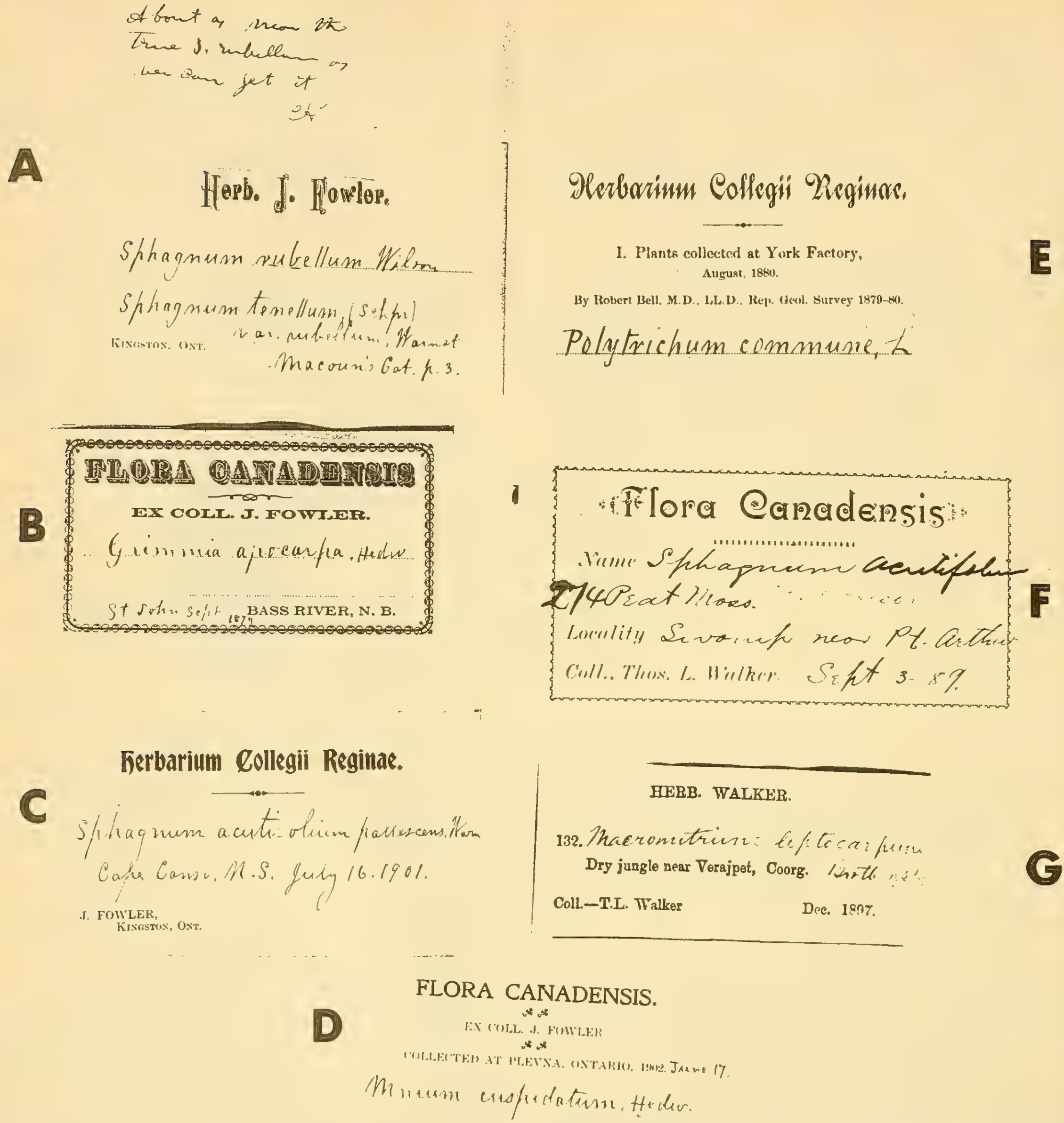

FIGURE 3. A–D. Labels used by Fowler: A has the superscription 'About as near the true *S. rubellum* as ever can get, A.' by C. F. Austin. E. An example of Robert Bell's labels. F, G. Specimens from the Canadian and Indian collections of T. L. Walker. The Indian species was a new one described by Brotherus. Photographs by Neil Carter.

after day. Mr. Roy called himself our man Friday and carried a basket. We collected many mosses and flowering plants the former of which were sent to Professor James who was then preparing his manual of North American Mosses" (Macoun 1922). The labels next show Mrs. Roy visiting Scotland in July 1873, and Switzerland in August. She shared the romantic tastes of the 1830's collector, looking at the Trossachs, at 'Alton Towers, seat of the Earl

of Shrewsbury,' and scraping the moss off the cobbles in front of the church of the Madeleine and the tombstone of Abelard in Père la Chaise.

Mrs. Roy is an excellent example of the nineteenth century exchange network, sending off her specimens to be vetted and receiving species with which to compare them. In the absence of letters it is impossible to know how many plants reached her at second-hand. The herbarium contains 98 species sent to her by Professor Paul Reinsch, of Erlangen, near Nürnberg, the author of *Herbarium Muscorum Frondosum Europaeae mediae* (1871–1872). The large collection of the Reverend Ian Ferguson seems to have been sent to her, as the majority of labels have her name on the left-hand side, and only rarely Macoun's or Fowler's (See Figure 2B). Ferguson's specimens are from Aberdeenshire and Forfarshire (for example, 'the manse garden, New Pitsligo, Aberdeenshire') but he also climbed Ben Lawers and distributed arctic–alpine species from there. Some of his original newsheet wrappings now provide entertainment after a century. He occasionally forwarded moss from other collectors, for instance a Curnow specimen of *Campylopus* collected in Cornwall in the 1870's. It is possible that the early British specimens were part of Mrs. Roy's collection, as she certainly possessed Wilson's (1855) book.

The European exchange material acquired at this time is fairly representative. In addition to the British material described, there is a group of 136 from Yorkshire, collected by J. Baker, and distributed by M. S. Bebb. Westmoreland specimens collected by J. M. Barnes were distributed by T. P. James, who also passed on a general British collection of G. E. Hunt (see Figure 1F). Hunt's moss shows the complexity of the exchanges as other specimens of his were sent on by Ferguson and by W. W. Denslow.

After the British group the next largest is the Scandinavian. This is because the first half of a set of Finnish *exsiccata* (some 450 items) sold by V. F. Brotherus were acquired. The set was issued in 1871–1888, and whoever obtained it seems to have divided some specimens; some have Mrs. Roy's writing on them, and Fowler relabelled at least one. S. O. Lindberg, a Swede who was professor at Helsingfors from 1864 to 1889, also contributed northern plants, and there are some from J. O. Bomansson, who collaborated with him, and with K. F. Thedenius, who had taught him (Collander 1965).

Germany was the center of bryology, and Reinsch's material has already been described. Queen's University does not seem to have had any direct contact with W. P. Schimper, but 68 specimens from the Schimper Herbarium were exchanged by the Honorable G. W. Clinton, who lived at Buffalo, New York (Humphrey 1961). They were collected by several botanists, mostly in the Vosges and the Jura. The labels do not show how Clinton obtained them, or when he exchanged them; the most likely contacts are L. Lesquereax, who had collected with Schimper and who settled in Ohio, and T. P. James, who went to Strasbourg to meet him in 1878 (Gozzaldi 1903). P. Bruch is also represented, again by specimens from the Vosges. Northern Germany was not so productive: there are only some 30 mosses from near Berlin, collected by P. Magnus in the 1860's.

J. Breidler and J. Juratzka who, like Schimper and Bruch (Bruch et al. 1836–1855) were authors of European moss floras, were the collectors of some Austrian species dating from 1868, and there is more Austrian material in Cufino Herbarium duplicates which seem to have been sent to Mrs. Roy. The Cufino Herbarium plants and a collection from J. Caruel are the only old Italian specimens.[3] In 1870–1871 Fowler received an exchange of Belgian and Luxembourg mosses from the Verheggen collection.

A few exotics were obtained from outside Europe, for example a *Meteorium* from the New Hebrides. There is a pair of Australian mosses from Baron von Mueller, which may have accompanied the volume of his *Analytical Drawings of Australian Mosses* that he presented to the Botanical Society in 1864.

While the reference collection was being built up, the frontiers of Canada and the United

States were expanding. Macoun's trip to the Pacific was followed by later travels in the Rockies, the prairies, and British Columbia, while Bell collected at Hudson's Bay, and Fowler also went to Vancouver in 1903 (see Figure 2D, E; Figure 3E). The Maritimes collection Fowler had made was extended by John Moser. The earliest plants from the United States naturally came from the northeast, but by the turn of the century the sources included Florida, California, and Washington.

Both Fowler and Macoun were helped by C. F. Austin in their identifications, so it is not surprising that there is a set of *exsiccata* from the Appalachians and numerous mosses from New Jersey, where he lived at Closter. His specimens can often be identified by an elaborately drawn "A" on them (cf. Figure 3A). A copy of his *Musci Appalachiani* (1870) in the herbarium library is addressed to Fowler; occasionally a plaintive note appears, as when Fowler wrote on *Sphagnum tenellum* "Austin kept my specimen and sent this in its stead."

Another referee was C. Peck, a professor at New York State College at Albany (Humphrey 1961). Peck's own material came from Albany and his home at Sand Lake. Peck also passed on specimens from Clinton and Austin.

The third referee in the United States was James, to whom reference has already been made. He illustrated Lesquereux and James' (1884) *Manual of the Mosses of North America,* and distributed mainly European material, but there are a dozen species from near his home at Cambridge, Massachusetts. His specimens, or those which he distributed, often have the initials T.P.J. written in a small and elegant hand (cf. Figure 1F). The professorship to which Macoun alluded was in pharmacy.

American exchanges were also made with Mrs. E. Jane Spence of Springfield, Ohio, Mr. French of Illinois, and Dr. Charles Mohr of Alabama. Mrs. Roy received moss from the Sierra Nevada, collected by T. S. Brandegee in 1877, and from H. N. Bolander in California. Some of Bolander's plants were transmitted by M. S. Bebb, who unfortunately never dated envelopes. As the population of the continent grew the exchanges reflected the settlement; Michigan mosses were sent by E. C. Almedingen at Ann Arbor, Pennsylvanian by J. K. Small, Carolinian by Small and A. A. Heller, who published an account of its flora in 1892. Very beautiful specimens, some of them from Montana, were collected by Professor Umbach, of Northwestern University of Evanston.

Just as Lawson had inspired the first group of Kingston botanists, Fowler also led a group of local collectors. The area around Kingston covered by the collections of Miss A. Boyd, Alexander Ross, and W. Nicol was not much larger than that in which Lawson had worked. Peel County had a more enthusiastic group of amateurs, whose collections in the herbarium are often annotated by Macoun. James White, R. Lees, and Thomas L. Walker went individually or in pairs on moss forays to the River Credit, to Edmonton (later renamed Snellgrove) and Snell's Lake in Peel County, and to Stony Lake in Peterborough County.[4] Both Austin and Macoun made reference to White's records. Lees appears to have led a sedentary life, at Credit Forks and Brampton, where he collected in "damp places on Brampton streets." The numerous schoolbooks which he chopped up for labels suggest that he was a teacher and his address in 1890 was Brampton High School.[2] Dr. Walker, on the other hand was in Manitoba in 1889, in Kingston for one day in 1892 when he made a large collection and even climbed the roof of the Grand Trunk brewery, and at Spanish River, Parry Sound, Lake Huron, and Murray Mines in the next year. The Sudbury location gives the key to his identity, as the Geological Survey records have a mining report by Dr. Thomas L. Walker from Sudbury, which falls in the right year, and shows also that he had previously worked with Dr. R. Bell in 1890. In 1897–1898 he went to the Indian hill state of Coorg, west of Mysore, and amassed some 240 mosses, which came to Queen's with his 100 from Ontario. James White's associa-

[2]He is listed as a member of *The Canadian Botanists' Correspondence Association,* December 1890, as are James White, Professor Fowler, Professor John Macoun and his son James. A circular describing the association is in the herbarium; it was printed at Wingham, Ontario.

tion with Macoun and with Walker suggest that he was the James White who became geographer to the Geological Survey in 1894, and late chief draughtsman; but in 1890 his address was Edmonton, Ontario, rather than Ottawa which would be a more likely address for the draughtsman. White and Lees added more than 100 specimens.

Walker's Indian collection is the most interesting group of foreign mosses in the herbarium and contains several isotypes. A letter to Professor Fowler explains that there were four sets of *exsiccata,* and that the identifications were made by Brotherus. Figure 3F, G illustrates Walker's labels; G is one of the new species described by Brotherus. The letter is printed here fully, as it gives such a vivid picture of an intrepid Victorian geologist and bryologist and his enormous retinue.

Naini Tal N.W.P.
June 27th, 1899

My Dear Professor:—

Your letter received some time ago but I put off replying till I could tell you about the mosses — well Brotherus has described them and they contain in all about one hundred species, twenty of which are new and six have been called "— *Walkeri*". I sent about 300 specimens but as you will see they contained many duplications — the descriptions of the new mosses are in Latin, but that will be no difficulty to you. I sent you a set of labels with the names written or pasted on about 270 of the 300, those unnamed are probably poor specimens of such a nature as to be unfit for determination. In all cases the localities and dates are printed. I did not send you a full set of mosses — some of the rarer ones would not stand dividing into four full sets — you will thus have some tickets for which you have not the mosses, these tickets may be destroyed. I send also a copy of the descriptions one of six copies kindly given me by Dr. Prain [?] director of the Botanical Survey of India.

I am off now for a four months tour in the Himalayas — go to the extreme north of British territory and across into Tibet if allowed by the Tibetans — it is a fine fossil country along the frontier, principally Triassic. I will be for three months at an altitude of 12000 to 22000 feet — some of the passes being 19000 feet while I do not expect to be below 12000 feet for the whole time I am up there.

It will be cool and dry as I get beyond the snowy range and beyond the monsoon rains. I have a gun for bear, hare, partridge and sheep, goats and deer — but for any Tibetan who shows fight I have a big revolver — of course I will not seek to quarrel but if I must fight I suppose I shall.

I expect to collect a few plants up there if there are any — being on the north side of the Himalayas and at such high altitudes I expect they will be worth collecting. I shall probably collect only mosses or such others as require little work and are not bulky.

From here out everything will have to be carried by coolies for whom I will have about 20–25 loads — they will cost four annas (8 c.) a day. I take a cook, a man to look after my clothes and wait at table, a messenger, a huntsman and probably his assistant, 20 or 25 pack coolies — possibly a small flock of goats and sheep for milk and meat and a man to look after them. To this long list I will probably add a couple of local men as guides.

Naini Tal is a small hill station about 7000 feet above the sea level. We are halting here a few days till our outfits are complete and all the necessary servants are secured. I have never been in such a cool part of India before but at 20000 feet it will be much cooler. We will see plenty of glaciers and land slips.

I must now close hoping this finds you in good health enjoying your holidays — remember me to Miss Fowler and my Queen's friends.

Yours sincerely,
T. L. Walker

Fowler and Macoun both lived until after the Great War, but in their old age little was added to the herbarium except foreign exchanges from the National Herbarium. The moss collection was revived by Professor R. E. Beschel, who brought with him, in 1959, collections from Europe, the Maritimes, and the Arctic. The herbarium already contained a few arctic mosses in the early sets, including a Swedish *Mnium* and an *Orthotrichum* from 1843, *Lyellia crispa* from Nepal also collected in 1843, *Oncophorus virens* from Greenland in 1844 and Siberia in 1860, all predating Ferguson's Scottish plants and the Brotherus ones from Lapland. Interest is now centered in two areas; in the Arctic, to which G. R. Brassard's collection from Northern Ellesmere Island is the largest recent addition, and in the local Kingston area.

The collection of liverworts was accumulated in the same haphazard way as that of the mosses. Macoun and Fowler again contributed

the backbone of the group, and of the amateurs only Mrs. Spence seems to have been more interested in liverworts than mosses. Only since the 1950's has exchange material become abundant enough to be representative even of the Ontario flora.

From this account it can be seen how the cooperation of professional botanists and amateur naturalists has gradually built up a worthwhile collection. At present over 7000 specimens are accessible to visitors to the herbarium (QK) or on loan. The nomenclature of the American species accords with that of Crum et al. (1965), but changes in synonomy have been cross-referenced in the cabinets. All the plants of interest to the historical bryologist are available in this collection with the exception of Fowler's specimens amassed after 1890, which have not yet been added. In most cases the moss or liverwort is in good condition, and where possible the original labels have been preserved.

List of major collectors and herbaria. Titles are given only when these are habitually used on the labels; where the identification of the person is certain, initials have been added in some cases.

Almedingen, E. C.
Anderson, Mr.
Ångström, J.
Argus, G. W.
Atwater, Mr.
Austin, C. F.

Baker, J. G.
Barker, Professor
Barnes, J. M.
Barnston, G.
Barrett, Dr. P. L.
Barson, A.
Barwell, —.
Bebb, M. S.
Bell, Dr. R.
Bell, Mr.
Bergram, S.
Beschel, R. E.
Billings, B., Jr.
Blanchet, B.
Bolander, H. N.
Bomansson, J. O.
Boyd, Miss Annie
Brandegee, T.
Brassard, G.
Breidler, J.
Brigham, —.
Brisson, S.
Brotherus, V. F.
Bruch, P.

Caruel, J. C.
Chalmers, R.
Chaney, R. W.
Clinton, G. W.
Colim, V.
Crum, H.
Cufino Herbarium
Curnow, Mr.
Curtiss, Mr.

Davies, G.
Denslow, W. W.
Drummond, A.

Eaton, D.
Edwards, H. W.
Ferguson, Reverend I. F.
Foster, A. S.
Fowler, J.
French, G. H.

Garton, E.
Garwood, A. E.
Giordana, —.
Good, H. M.
Good, M.
Gordon, Mr.
Gray Herbarium
Grosvenor, J. W.

Hainault, R.
Hall, E.
Hand, C. H.
Hay, G. N.
Hazlinszky, F.
Heller, A. A.
Hincks, Professor W.
Hoffmann, W.
Holler, A.
Holmby, J. L.
Holmen, K.
Holmes, Mr.
Howe, E. C.
Hunt, G. E.
Hutchinson, E.

Ireland, R. R.

James, T. P.
Jeglum, J. K.
Jones, G. N.
Jones, J. M.
Juratzka, J.

Kallio, P.
Kiaer, Dr.
Kindberg, N. C.
King, J.
Klugh, A. B.

Lackström, E. F.
Lawson, G.
Lees, R.
Legault, A.
Levier, E.
Lindberg, S. O.
Lindgren, S. J.
Lindsay, Dr. L.
Little, T.
Looff, E. and H.
Louis-Marie, Père

MacClement, W. T.
MacDonald, J.
Macdonald, I.
Macoun, John
Magnus, P.
Mann, —.
Markus, A.
McAndrews, Mr.
Milde, Dr.
Mohr, Dr. C.
Moser, J.
Motelay, L.
Murdy, R W.

Nicol, W.

Orcutt, C. R.

Palmer, Dr. E.
Palmer, T. (?) A.
Parker, C. F.
Patterson, H. N.
Peck, C. H.
Polakowsky, H.
Porsild, M. P.
Porter, Professor

Ravenel, H. W.
Reinsch, P.
Reuter, R.
Ripley, A. B.
Robinson, —.
Romer, C.

Ross, A. H. D.
Roy, J. (Mrs. W.)

Samuels, E.
Schimper Herbarium
Schofield, W. B.
Schwartz, Dr.
Scotter, G. W.
Shaw, J.
Skinner, D.
Small, J. K.
Sorensen, T.
Spence, Mrs. E. J.
Steere, W. C.
Stewart, J. H.

Tavares, I.
Tuohy, H.

Umbach, Professor L. M.

Vasey, Dr. G.
Venturi, G.
Verheggen Herbarium
Von Mueller, Baron F.

Walker, T. L.
Wallnöfer, A.
Walter, C.
Warnstorf, C.
Waterbury, Miss R.
Webber, P.
Weber, W. A.
Weiss, E.
Wetmore, J. E.
Whalley, J. E.
White, J.
Williams, C.
Winter, J.
Wiley, D.
Wilson, Mr.
Wood, Dr. G. B.
Woods, A. A.

Zavitz, C. H.

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Addenda

[3]An elementary treatise in botany and a Tuscan flora, both written in Italian by Caruel, were inscribed as having been received by the Botanical Society in 1861.

[4]An island in Stony Lake (or Stoney Lake as it is sometimes spelt) was the site of a cottage belonging to Mrs. Traill. Her eminence as a Canadian wild-flower collector had been established by the publication of her books in 1868 and 1884. Despite her age she was an active botanist until her death in 1899. It may have been to visit her that excursions to Stony Lake were made. A biography of Catherine Parr Traill, *Lady of the Backwoods,* written by S. Eaton, was published in 1969 by McClelland and Stewart, Toronto.

Vascular Plant Range Extensions in the Northern Yukon Territory and Northwestern Mackenzie District, Canada

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Wein, R. W., L. R. Hettinger, A. J. Janz, and W. J. Cody. 1974. Vascular plant range extensions in the northern Yukon Territory and northwestern Mackenzie District, Canada. Canadian Field-Naturalist 88: 57-66.

Abstract. Plant communities of the Yukon Territory and northwestern Mackenzie District north of 67° N were investigated during the summers of 1971 and 1972. This paper lists 70 vascular plants that were found outside the ranges predicted by Hultén (1968). Information given by Cody and Porsild (1968), Porsild and Cody (1968), and Welsh and Rigby (1971) is discussed in light of our range extensions.

Introduction

During the summers of 1971 and 1972 plant collections were made in the northern portion of the Yukon Territory and in the Peel Plateau of the Richardson Mountains in northwestern Northwest Territories in connection with work investigating soils–vegetation relationships. In total, 80 species of lichens, 52 species of mosses, 14 species of sphagna, four species of liverworts, and over 300 species of vascular plants were collected. A total of well over 3,000 collections were made during the two years.

Few vascular plant collections had previously been made in the area: in 1962 J. A. Calder of the Plant Research Institute made collections in the British and Richardson Mountain regions, but these records were never published; Hultén (1968) records only six collecting localities. Recently collections have been made by Lambert (1968) at Trout Lake in the Northern Yukon and at Canoe Lake in the Richardson Mountains of the Mackenzie District, while Welsh and Rigby (1971) made extensive collections over much of the present study area west of the Richardson Mountains. Cryptogamic specimens are known only from Lambert's work.

In this paper we have recorded only those vascular plants that we found outside the range predicted by Hultén (1968). The cryptogams which are the first major contribution of these groups for this region will be reported in a separate paper.

Figure 1 gives the study area and the 22 major collecting sites. The study area is approximately 240 × 230 km and varies from the diverse topography of the Richardson Mountains (elevations to 1720 m) in the east to the almost level area of the Old Crow Flats (at 300 m elevation) in the west near the Alaska border. The reader is referred to Bostock (1961) for a more complete physiographic treatment.

At each collection site, plants were collected from the major communities and more specialized habitats such as rock outcrops, snowbeds, and soil slumps. Emphasis was placed on upland and stream-side communities rather than aquatic habitats.

Collection Site Characteristics

Collection sites 1 (67°12′ N, 135°10′ W), 2 (67°16′ N, 134°56′ W), 3 (67°22′ N, 134°59′ W), 4 (67°18′ N, 135°08′ W), 5 (67°21′ N, 135°34′ W), and 6 (67°22′ N, 135°47′ W) are located on the gently sloping eastern flank of the Richardson Mountains in the Mackenzie District at elevations between 30 and 660 m, called the Peel Plateau. At the lower part of the slope, sedge and small shrub communities are found in the wetter areas while *Picea mariana* and *P. glauca* and some *Larix laricina* are dominant on the drier sites. Small patches

FIGURE 1. Location of 22 collection sites in the northern Yukon Territory and northwestern Northwest Territories. Collection sites by Lambert (1968) (L) and the most intensively collected area by Welsh and Rigby (1971) (W&R) are also given. The latter authors had many other collection points scattered from Old Crow to the coast and as far east as the Richardson Mountain foothills.

of grassland are found on the very dry south-facing slopes above the Peel River. Higher on the plateau trees are only common in the river flood-plains, while cottongrass tundra with *Salix* spp.-covered stream channels dominate the upland. Soils are generally poorly drained, acidic (pH 4.5–7.0), and of silt and clay textures.

Streamside terraces on Regosolic soils are dominated by *Picea glauca, Populus balsamifera, Alnus crispa* ssp. *crispa,* and *Salix pulchra* at lower elevations, but at the upper part of the plateau *Alnus crispa* ssp. *crispa* is predominant on these sites.

Collection sites 7 (67°27′ N, 136°32′ W), 8 (67°22′ N, 136°32′ W), and 9 (67°43′ N, 136°32′ W) represent the Richardson Mountain alpine communities west of the Yukon–Mackenzie District border, between 660 and 1470 m; they range from wet sedge meadows,

to dry gravel soils with sparse vegetation, to intensively frost sorted polygons, to feldfield communities. Soils are Regosols and plants are restricted to pockets of silty loam with slightly acidic materials.

Sites 10 (67°21′ N, 136°45′ W), 11 (67°27′ N, 137°14′ W), 12 (67°38′ N, 138°35′ W), and 13 (67°38′ N, 139°10′ W) lie between 350 and 700 m above sea level and represent the most heavily forested part of the study area. Fires have been common. Most of the area has been burned in past years and there are no lichen-dominated communities. Sedge communities are prevalent in wet areas: *Picea mariana* dominates the mesic sites, while *Betula papyrifera* and *Picea glauca* dominate the dry southern exposures.

The terrain is gently undulating with rock outcrops and ridges that have Regosolic soils. Other soils are acidic (pH 5.5–7.0), clayey to silty in texture, and moderately well drained.

Sites 14 (67°43′ N, 139°47′ W) and 15 (67°40′ N, 140°08′ W) are two major transects that start in *Picea mariana* and *Picea glauca* communities at about 350 m elevation and extend into the alpine communities that begin at about 650 m. Shrubs of *Alnus crispa* spp. *crispa* and *Betula glandulosa* dominate the sloping areas. *Eriophorum vaginatum* dominates the level areas of the lower tundra communities. With increased elevation *Betula glandulosa* becomes dominant on the slopes and *Carex* spp, are predominant in the level areas.

Soils tend to be acidic (pH 5.5–6.0), silty clay loam in texture, poorly drained, and conducive to solifluction activity at higher elevations.

Site 16 (68°33′ N, 138°35′ W) in the Barn Mountains is located in rounded mountains that rise to 1100 m from the general level of the Arctic Plateau. This treeless area has *Salix pulchra* along the stream channels with cottongrass on level areas of the upland and dwarf shrubs (*Salix* spp., *Betula glandulosa*) on the slopes. Gravel outcrops and ridges are dominated by *Dryas* spp. The rolling terrain is generally moderately-to-well drained and the fine-textured soils are acidic (pH 5.5–7.0).

Site 19 (69°13′ N, 139°35′ W) represents the British Mountains physiographic region. Communities in which collections were made ranged to 800 m and were found in broad valleys with scattered rock outcrops. Several *Picea glauca* trees were found in sheltered areas, but sedge meadow communities on level areas and forb communities in drainage channels constitute the major communities. Regosolic soils, neutral in pH and imperfectly drained, predominate. Solifluction activity is common on slopes.

The Arctic Coastal Plain is represented by sites 18 (68°47′ N, 137°10′ W), 20 (69°23′ N, 139°20′ W), and 22 (69°30′ N, 139°27′ W). Drainage is poor in this rolling to nearly flat topography, and sedge communities, especially the cottongrass tussock community, are common. Soils are very acid (pH 4.5). The silty soils show polygonal patterns, and thermokarst topography is common around lakes and stream channels. Alluvial fans are common on the lower portions of streams. Many forbs and grasses find a foothold in these unstable gravel and sand deposits. Shrubs along small stream channels are mainly *Salix pulchra* and *S. glauca* ssp. *acutifolia*.

Sites 17 (67°42′ N, 137°17′ W), and 21 (69°28′ N, 139°42′ W) are also included in this physiographic region, but in contrast to the sites above, are higher in elevation (240–460 m) and represent rock outcrops with variable soil texture, slopes, and drainage.

Vascular Plant Range Extensions

The following 70 species names are followed by collection sites, elevation in meters, habitat, collection date, and collection number (italicized). Nomenclature follows Hultén (1968), but where names used by Porsild and Cody (1968) differ, these are given in parentheses. Collection numbers are those of the senior author and correspond to the stands where intensive soils and vegetation measurements were also made. Thus collection numbers are the same for species found at the same stand. A complete set of voucher specimens is deposited at the Plant Research Institute Herbarium in Ottawa (DAO).

Our collections provided six more species for Zone 2 (Richardson Mountains) of the Continental Northwest Territories checklist published by Porsild and Cody (1968). These are *Equisetum sylvaticum* L., *Sparganium angustifolium* Michx., *Polygonum aviculare* L., *Chenopodium album* L., *Caltha palustris* L. ssp. *arctica* (R.Br.) Hult., and *Veronica wormskjoldii* Roem. & Schult. ssp. *wormskjoldii*.

Welsh and Rigby (1971) reported numerous range extensions for plant species in the northern Yukon. Sixteen of their species were extentions over the ranges predicted by Hultén (1968) and were also collected as range extensions in the present study. In addition, 37 species not represented among the material gathered by those authors were found among our collections and are reported here as extensions of the ranges predicted by Hultén (1968).

The number of range extensions at any site was primarily a function of the amount of time spent in the area. In addition, sites 7 and 10 were often not included in the predicted ranges given by Hultén (1968) because they were not generally recognized as being alpine. These areas did, however, have small mountain peaks with floras that had affinities with higher mountain ranges.

As more collecting is done in the northern Yukon more range extensions will no doubt be found. The northern Richardson Mountains, in particular, and some of the higher peaks in the British Mountains may prove interesting. It is felt that the range extensions recorded by Welsh and Rigby (1971) and in the present paper greatly improve the predicted distributions of Hultén (1968) and those of Porsild and Cody (1968) for their Zone 2 of the Continental Northwest Territories.

Lycopodium complanatum L. Site 10: 430 m, paper birch, July 5, 1972, *126*; site 10: 430 m, paper birch, July 9, 1971, *125*; site 12: 370 m, burned black spruce, June 25, 1972, *237*; site 13: 580 m, rock outcrop, June 29, 1972, *7H*. These sites in the Yukon River drainage are, with the exception of a collection from the Alaska side of the border, far north of any other site in the Yukon Territory; Porsild and Cody (1968), however, record it in their Zone 2.

Equisetum sylvaticum L. Site 4: 180 m, black spruce, June 18, 1971, *108*; site 10: 400 m, black spruce, July 10, 1971, *128*; site 12: 460 m, black spruce, June 23, 1972, *232*; site 12: 460 m, burned black spruce, June 23, 1972, *235*; site 13: 330 m, short shrub, July 1, 1972, *142*. This species is new to Zone 2 of Cody and Porsild (1968) and an extension of the range north from the Dawson region in the Yukon Territory.

Gymnocarpium dryopteris (L.) Newm. (*Dryopteris disjuncta* (Ledeb.) Morton). Site 9: 710 m, rock outcrop, July 13, 1972, *17D*. This site in the Richardson Mountains near the Mackenzie District border is an extension of the known range in the Yukon from south of latitude 65° N.

Larix laricina (Du Roi) K. Koch. Site 4: 180 m, black spruce, June 19, 1971. *108*. This collection is a westward extension of the species for Hultén's (1968) map, but Porsild and Cody (1968) have recorded it for their Zone 2.

Picea glauca (Moench) Voss. Site 19: 460 m, stream channel, July 20, 1972, *262*; site 19: 400 m, rock outcrop, July 21, 1972, *264*. These collections extend the range given by Hultén (1968) east of the Firth River valley and slightly farther north. Collections by Welsh and Rigby (1971) did not extend the range.

Juniperus communis L. ssp. *nana* (Willd.) Syme. Site 19: 430 m, rock outcrop, July 21, 1972, *264*. This collection suggests that this species may be found in other parts of the British Mountain system above 69° N. Porsild and Cody (1968) record it for their Zone 2.

Sparganium angustifolium Michx. Site 3: 60 m, lakeside, August 18, 1972, *10L*. This species is new to Zone 2 of Porsild and Cody (1968); the map in Hultén (1968) does not include localities in the Mackenzie River Delta region upon which Porsild and Cody (1968) based their report for Zone 3.

Poa alpina L. Site 7: 710 m, willow stream channel, July 9, 1972, *257*; site 10: 400 m, willow–grass–poplar on gravel, July 5, 1972, *246*. These localities in the Richardson Mountains of the Yukon Territory help fill in the known northern distribution between sites in northwestern Mackenzie District and northwestern Yukon. The specimen collected by Welsh and Rigby (1971) did not extend the range predicted by Hultén (1968).

Bromus pumpellianus Scribn. var. *arcticus* (Shear) Porsild. Site 7: 710 m, willow stream channel, July 10, 1972, *257*; site 10: 600 m, gravel outcrop, July 9, 1972, *4H*; site 22: 3 m, sand dune, July 20, 1972, *14SD*. These collections extend the prediction made

by Hultén (1968). Collections by Welsh and Rigby (1971) were within the predicted area.

Carex eleusinoides Turcz. Site 7: 400 m, willow–grass–poplar on gravel, July 5, 1972, *246*. This Amphi-Beringian species, according to the map in Hultén (1968), is not otherwise known in the Yukon from north of about 64° N.

Allium schoenoprasum L. var. *sibiricum* (L.) Hartm. Site 14: 270 m, river bank, August 14, 1971, *9OCR*; site 19: 400 m, sedge meadow, July 17, 1972, *266*; site 19: 400 m, stream channel, July 22, 1972, *268*. The map in Hultén (1968) does not show any collections in the Yukon from north of about 64° N, although in both Alaska and Mackenzie District the species occurs at least as far north as the localities cited here and in Welsh and Rigby (1971).

Cypripedium passerinum Richards. Site 9: 300 m, moss heath, July 12, 1972, *17SL*. The only other locality shown on the map in Hultén (1968) from north of latitude 65° N in the Yukon is adjacent to the Alaska border.

Populus tremuloides Michx. Site 11: 400 m, paper birch slope, June 20, 1972, *227*. This site, a few miles west of the Mackenzie District border, helps complete our knowledge of the distribution of aspen in northern Yukon.

Salix depressa L. ssp. *rostrata* (Anderss.) Hiitonen (*S. bebbiana* Sarg.). Site 1: 210 m, tall shrub, June 17, 1971, *102*; site 1: 210 m, black spruce, June 20, 1971, *104*; site 10: 430 m, paper birch, July 4, 1972, *126*; site 11: 430 m, white spruce - willow, June 21, 1972, *229*. Porsild and Cody (1968) record this species from their Zone 2, but this distribution is not included on the map in Hultén (1968). This map shows nothing in the Yukon from north of about 64° N but does have a dot along the Yukon River about the Alaska–Yukon border.

Polygonum alaskanum (Small) Wight. Site 3: 150 m, seismic line disturbance, August 18, 1972, *10S*. Porsild and Cody (1968) record this species from their Zone 2, but these collections from the Peel Plateau are from south of their localities. Welsh and Rigby (1971) record four collections but these are within the range predicted by Hultén (1968).

Polygonum aviculare L. Site 3: 150 m, seismic line disturbance, August 18, 1972, *10S*. This species was not previously recorded for Zone 2 of Porsild and Cody (1968).

Chenopodium album L. Site 3: 150 m, seismic line disturbance, August 18, 1972, *10S*. This species was not previously recorded for Zone 2 of Porsild and Cody (1968).

Cerastium maximum L. Site 10: 550 m, dry slope, July 9, 1972, *4H*; site 11: 430 m, grass slope, June 22, 1972, *231*. This is an eastward extension of the range up the Yukon River valley from about 140° W longitude.

Minuartia arctica (Stev.) Aschers. & Graebn. (*Arenaria arctica* Stev.). Site 6: 400 m, rock outcrop, July 14, 1971, *5R*; site 8: 610 m, sedge meadow, July 9, 1972, *252*; site 9: 1000 m, gravel outcrop, July 13, 1972, *17D*; site 9: 810 m, gravel slope, August 30, 1972, *319*; site 10: 650 m, gravel ridge, July 9, 1972, *4H*; site 10: 610 m, rock outcrop, July 9, 1972, *4H*; site 14: 370 m, gravel hilltop, August 14, 1971, *140*; site 20: 50 m, cottongrass tundra, July 18, 1972, *267*. This species is known from numerous localities in the Richardson and Mackenzie Mountains of the Mackenzie District and does, in fact, occur as far east as Great Bear Lake although this information does not appear on the map in Hultén (1968). The localities given here together with range extensions presented by Welsh and Rigby (1971) indicate that it is frequent across the northern parts of the Yukon Territory.

Minuartia obtusiloba (Rydb.) House (*Arenaria obtusiloba* (Rydb.) Fern.). Site 14: 640 m, gravel hilltop, August 15, 1971, *151*. Porsild and Cody (1968) have this species from both Zones 2 and 3; the map in Hultén (1968), however, for northern Yukon shows only one collection from the Arctic coast and one from the Alaska–Yukon border.

Minuartia rossii (R. Br.) Graebn. (*Arenaria rossii* R. Br.). Site 22: 3 m, sand dunes, July 20, 1972, *14D*. This collection from near the Arctic coast of northwestern Yukon is an extension of the range northward from along the Alaska–Yukon border in the Brooks Range. The two collections given by Welsh and Rigby (1971) fall within the predicted range given by Hultén (1968).

Wilhelmsia physodes (Fisch.) McNeill (*Arenaria physodes* Fisch.). Site 20: 50 m, willow snow-bed, July 22, 1972, *283*. This is a slight northward extension of the known range to the Arctic Coastal Plain of the Yukon Territory from the British Mountains. The collection by Welsh and Rigby (1971) falls well within the predicted range given by Hultén (1968).

Silene acaulis L. ssp. *acaulis* (*S. acaulis* L. var. *excapa* (All.) DC.). Site 16: 710 m, *Dryas–Saxifraga–Potentilla*, August 10, 1972, *284*. Hultén (1968) does not show any collections from northern Yukon. The collection by Welsh and Rigby (1971) extended the range south of the range predicted by Hultén (1968).

Melandrium affine J. Vahl. Site 10: 400 m, willow–grass–poplar gravel, July 5, 1972, *246*. Welsh and Rigby (1971) recorded one collection within the range predicted by Hultén (1968).

Caltha palustris L. ssp. *arctica* (R. Br.) Hult. (*C. palustris* var. *arctica* (R. Br.) Huth). Site 3: 140 m, white spruce – alder, August 20, 1972, *209*. This species was not previously recorded from Zone 2 of Porsild and Cody (1968). The specimen collected by Welsh and Rigby (1971) falls within the range predicted by Hultén (1968).

Delphinium brachycentrum Ledeb. Site 9: 980 m, wet meadow, July 13, 1972, *17D*. Hultén (1968) shows a single collection from northern Yukon from a site in the Richardson Mountains north of our locality.

Corydalis pauciflora (Steph.) Pers. Site 7: 980 m, dwarf willow slope, July 5, 1972, *247*. This locality in the Richardson Mountains just west of the Mackenzie District border is from south of the two localities shown by Hultén (1968) in the British Mountains. To the south it is found south of latitude 65° N.

Corydalis sempervirens (L) Pers. Site 8: 430 m, paper birch, July 9, 1971, *126*. Previous Yukon collections plotted by Hultén (1968) all lie south of latitude 64° N; there is, however, a site in the Mackenzie River Delta area at roughly our latitude, according to Hultén (1968).

Cardamine microphylla Adams (*C. minuta* Willd.). Site 7: 980 m, dwarf willow slope, July 5, 1972; *247*; site 7: 710 m, willow stream channel, July 9, 1972, *257*. Cody and Porsild (1968) extended the known range of this species into the Richardson Mountains of northwestern Mackenzie District on the basis of collections by J. A. Calder; the two collections by Welsh and Rigby (1971) were the first range extension outside the range predicted by Hultén (1968).

Smelowskia calycina (Steph.) C. A. Mey. ssp. *calycina* var. *media* (Drury & Rollins) Hult. Site 9: 1000 m, gravel ridge, July 13, 1972, *17D;* site 9: 1030 m, rock outcrop, July 13, 1972, *17D;* site 9: 810 m, saxifrage gravel, August 30, 1972, *319*; site 19: 400 m, ridgetop, July 17, 1972, *260*; site 19: 1100 m, rock outcrop, July 17, 1972, *12BM*; site 21: 520 m, *Dryas* rock outcrop, August 19, 1972, *271* (glabrous form). Hultén (1968) recorded this plant from northern Alaska north of the Brooks Range and from the Richardson Mountains in Mackenzie District. The collections cited here are additional sites for the Yukon to those recorded by Welsh and Rigby (1971).

Arabis lyrata L. ssp. *kamchatica* (Fisch.) Hult. (*A. lyrata* var. *kamchatica* Fisch.). Site 7: 400 m, willow–grass–poplar, July 5, 1972, *246*. This is a northward extension of range in the Yukon Territory from latitude 65° N (Hultén 1968).

Erysimum pallasii (Pursh) Fern. Site 10: 610 m, gravel ridge, July 9, 1972, *4H*. This collection is from south of those mapped by Hultén (1968) in the northern part of the Yukon Territory; the species is then disjunct to central Yukon at about latitude 65° N where it is apparently rare. The collections by Welsh and Rigby (1971) are within the predicted range given by Hultén (1968).

Boykinia richardsonii (Hook.) Gray (*Therofon richardsonii* (Hook.) Ktze). Site 16: 650 m, dry slope, August 10, 1972, *305*. Hultén (1968) gives only one location in the far northwest part of the Yukon at longitude 140° W and another from the Yukon–Alaska border along the Yukon River. The dot on the map in the Richardson Mountains of Mackenzie District near the Arctic Coast is according to Hultén (personal communication) his interpretation of the report of Macoun "West of Mackenzie River, Simpson." Two collections of Welsh and Rigby (1971) extend the range given by Hultén (1968) well southward.

Saxifraga eschscholtzii Sternb. Site 19: 400 m, rock outcrop, July 17, 1972, *14BM*. This specimen was found very close to the range extension specimen collected by Welsh and Rigby (1971) in Alaska; it is new to the flora of the Yukon Territory.

Saxifraga bronchialis L. ssp. *funstonii* (Small) Hult. Site 10: 610 m, rock outcrop, July 9, 1972, *4H*; site 14: 640 m, gravel ridge, August 10, 1971, *151*; site 19: 400 m, gravel outcrop, July 17, 1972, *267;* site 19: 430 m, frost boil – tussock, July 19, 1972, *277*; site 19, 950 m, *Dryas*–lupine slope, July 9, 1972, *256*; site 19: 1000 m, gravel ridge, July 17, 1972, *19a*; site 19: 1100 m, rock outcrop, July 17, 1972, *19a*; site 21: 520 m, *Dryas* rock outcrop, July 19, 1972, *271*. Hultén (1968) records only one collection from the northern part of the Yukon; Welsh and Rigby (1971) have one collection within this range; these and the collections cited above are more or less contiguous with collections in the Brooks Range and coastal plain of northern Alaska; they are apparently disjunct from populations in central and southern Yukon and Alaska.

Saxifraga exilis Steph. (*S. radiata* Small). Site 10: 610 m. snow-bed, July 9, 1972, *255*. This collection is from the Yukon River drainage; collections from the far north of the Yukon plotted by Hultén (1968) were from north of the height of land. The collection by Welsh and Rigby (1971) extended the predicted range slightly southward.

Saxifraga hieracifolia Waldst. & Kit. Site 9: 980 m, dwarf willow slope, July 5, 1972, *247*; site 9: 1000 m, heath slope, July 12, 1972, *17D*; site 16: 650 m, sedge meadow, August 11, 1972, *288*. Hultén (1968) plotted only two collections from north of 65° N in the Yukon: one was adjacent to the Arctic Coast and the other in the extreme northeastern part of the territory.

Saxifraga caespitosa L. Site 16: 650 m, gravel slope, August 11, 1972, *284*. Hultén (1968) does not show any collections of this species from north of latitude 65° N, but Welsh and Rigby (1971) have since reported two collections from that area.

Ribes hudsonianum Richards. Site 3: 150 m, white spruce–alder, August 20, 1972, *209*; site 3: 340 m, white spruce, August 24, 1972, *220*; site 11: 340 m, paper birch, June 21, 1972, *227*. There are several localities plotted on the map in Hultén (1968) from along the Alaska–Yukon border as far north as the Yukon River, but otherwise this species was not known in the Yukon Territory from north of 64° N. Hultén's (1968) map does not show collections from the Richardson Mountains in northwestern Mackenzie District, but Porsild and Cody (1968) report this species for their Zone 2.

Potentilla biflora Willd. Site 16: 650 m, gravel slope, August 11, 1972, *284*. Hultén (1968) has plotted only two localities in the northern part of the Yukon Territory, but Welsh and Rigby (1971) cite several collections from outside the predicted range. These are part of a population which extends across northern Alaska into the adjacent Yukon. It is then disjunct to the Ogilvie and St. Elias Ranges and the Mackenzie Mountains.

Potentilla elegans Cham. & Schlecht. Site 19: 1100 m, rock outcrop, July 17, 1972, *14BM*. This Amphi-Beringian species is composed of a number of disjunct populations (Hultén 1968). Welsh and Rigby (1971) reported the first collections from northern Yukon.

Potentilla uniflora Ledeb. (*P. ledebouriana* Porsild). Site 9: 1030 m, gravel outcrop, July 13, 1972, *17D*; site 9: 1000 m, gravel outcrop, July 13, 1972, *17D*; site 9: 950 m, gravel outcrop, July 13, 1972, *17D*; site 13: 580 m, rock outcrop, July 9, 1972, *7H*; site 14: 640 m, gravel hilltop, August 10, 1971, *9GH;* site 16: 710 m, *Dryas–Saxifraga–Potentilla*, August 10, 1972, *284*. These records, together with those of Welsh and Rigby (1971), extend the known range of this species southward into the Yukon River drainage from the sites plotted by Hultén (1968).

Dryas octopetala L. ssp. *alaskensis* (Porsild) *Hult.* (*D. alaskensis* Porsild). Site 6: 400 m, rock outcrop, July 14, 1971, *5R*; site 6: 400 m, hummocky tundra, July 17, 1972, *111*; site 7: 980 m, dwarf willow slope, July 5, 1972, *247*; site 10: 710 m, gravel ridge, July 9, 1972, *4H*. The latter two collections are the first reported from northern Yukon; they are apparently part of the Richardson Mountain population, which is disjunct from populations in the Brooks Range in northern Alaska and populations from the Ogilvie Range and southward in the Yukon and Alaska (Hultén 1968).

Astragalus umbellatus Bunge. Site 10: 650 m, wet sedge slope, July 9, 1972. *4H*. This collection is an extension of the known range of the species southward into the Yukon River drainage from sites plotted by Hultén (1968). Welsh and Rigby (1971) have recorded additional collections from northern Yukon.

Oxytropis deflexa (Pall.) DC var. *foliolosa* (Hook.) Barneby. Site 3: 60 m, seismic line disturbance, August 18, 1972, *10S*. Hultén (1968) did not plot any specimens from the area between the Reindeer Grazing Preserve in northwestern Mackenzie District and the coastal plain of northeastern Alaska, but Porsild and Cody (1968) reported it for their Zone 2 on the basis of a specimen collected by J. A. Calder from the Yukon–Mackenzie border at latitude 67°57′ N. Welsh and Rigby (1971) reported one specimen that fell within the range predicted by Hultén (1968).

Oxytropis nigrescens (Pall.) Fisch. ssp. *bryophila* (Greene) Hult. (*O. pygmaea* (Pall.) Fern.). Site 22: 3 m, sand dune, July 20, 1972, *14SD*. The map in Hultén (1968) indicates collections from the Alaska–Yukon and Yukon–Mackenzie borders at about this latitude, but nothing between.

Cnidium cnidiifolium (Turcz.) Schischk. (*Conioselinum cnidiifolium* (Turcz.) Porsild. Site 10: 500 m, wet slope, July 9, 1972, *4H*; site 11: 340 m, grassland slope, June 22, 1972, *231*; site 14: 270 m, white spruce, August 13, 1971, *147*; site 14: 270 m, riverside, August 14, 1971, *9OCR*. The two northern Yukon sites shown on the map in Hultén (1968) are both adjacent to the Arctic Coast; Welsh and Rigby (1971) report another inland site at Old Crow on the Yukon River; in southwestern Yukon it is not known to occur north of 64° N.

Arctostaphylos alpina L. Spreng. Site 4: 210 m, tall shrub, June 18, 1971, *102*; site 6: 400 m, cottongrass tundra, July 16, 1972, *110;* site 6: 400 m, rock outcrop, July 14, 1971, *5R*; site 6: 400 m, hummocky tundra, July 17, 1971, *111*; site 9: 350 m, cottongrass heath, July 13, 1972, *17SL*; site 12: 550 m, burned black spruce, June 23, 1972, *6H*; site 15, 750 m, birch heath, August 29, 1972, *308*;

site 15: 750 m, cottongrass tundra, August 29, 1972, *306*; site 16: 650 m, frost boil slope, August 11, 1972, *307*; Although Hultén (1968) plots only one collection from the Arctic Coast and another from the Alaska–Yukon border in northern Yukon, Welsh and Rigby (1971) report one collection that was south of the predicted range.

Vaccinium uliginosum L. ssp. *alpinum* (Bigel.) Hult. Site 19: 460 m, willow stream channel, July 20, 1972, *262*; site 21: 500 m, hummock – frost boil, July 18, 1972, *273*. Hultén (1968) does not plot any specimens in the Yukon north of 65° N, but does show a collection from the Richardson Mountains in northwestern Mackenzie District from our latitude. Welsh and Rigby (1971) collected one specimen but did not give it a subspecies designation.

Vaccinium uliginosum L. ssp. *microphyllum* Lange. Site 8: 1050 m, polygonal ground, July 10, 1972, *254*. The only other site in northern Yukon plotted by Hultén (1968) is from about longitude 139° W.

Diapensia lapponica L. ssp. *obovata* (F. Schm.) Hult. (*D. obovata* (F. Schm.) Nakai). Site 7: 710 m, willow stream channel, July 10, 1972, *257*. This collection extends the known range south into the Yukon River drainage; it is apparently rare in the northeastern part of its range.

Douglasia ochotensis (Willd.) Hult. Site 14: 640 m, alpine birch, August 15, 1971, *152*; site 15: 650 m, willow slope, August 30, 1972, *310*. Welsh and Rigby (1971) reported this species as new to the Yukon Territory and cited three collections from their study area; these, together with the specimens reported here, help bridge the gap between the Richardson Mountain site in Mackenzie District and the northern Alaska localities plotted by Hultén (1968).

Douglasia arctica Hook. Site 6: 430 m, rock outcrop, July 14, 1971, *5R*; site 8: 1050 m, polygonal ground, July 10, 1972, *254*; site 10: 710 m, gravel ridge, July 9, 1972, *4H*; site 14: 640 m, gravel hill, August 15, 1971, *151*. These localities in the Yukon River drainage are all from south of the mountain and coastal sites plotted by Hultén (1968).

Dodecatheon frigidum Cham & Schlecht. Site 6: 400 m, snow-bed, July 14, 1971, *5S;* site 7: 710 m, willow stream channel, July 10, 1972, *257*. Earlier northern Yukon collections, according to the map in Hultén (1968), are from near Old Crow and adjacent to the Arctic Coast; in addition, Welsh and Rigby (1971) record several collections from inland sites. In the Richardson Mountains of Mackenzie District it has also been collected at Canoe Lake.

Phlox sibirica L. ssp. sibirica. Site 10: 720 m, gravel ridge, July 9, 1972, *4H*. Hultén (1968) does not show any localities from between the Alaska–Yukon border and the Canoe Lake area of the Richardson Mountains in Mackenzie District, but Welsh and Rigby (1971) cite several collections for this intervening area.

Polemonium boreale Adams ssp. *boreale*. Site 10: 650 m, wet meadow, July 9, 1972, *4H*; site 10: 400 m, willow–grass–poplar on gravel, July 5, 1972, *246;* These specimens extend the known range south from the height-of-land into the upper Yukon River drainage.

Polemonium pulcherrimum Hook. Site 10: 400 m, willow–grass–poplar on gravel, July 5, 1972, *246*; site 11: 430 m, paper birch, June 20, 1972, *227*. According to Hultén (1968) this sepcies is not known north of 64° N in the Yukon but it is found in the Reindeer Grazing Preserve in the northwestern Mackenzie District.

Eritrichium splendens Kearney. Site 9: 710 m, gravel outcrop, July 13, 1972, *17R*. Cody and Porsild (1968) reported this species as new to the flora of the Continental Northwest Territories on the basis of a specimen collected at Horne Lake in the Richardson Mountains by J. A. Calder in 1962. This was a range extension eastward from localities on the Alaska–Yukon border, as shown on the map in Hultén (1949) and again on Hultén's (1968) revised map. The specimen cited above is intermediate between the Alaska–Yukon border and the Richardson Mountains, and documents the occurrence of *E. splendens* in the northern Yukon Territory.

Myosotis alpestris F. W. Schmidt ssp. *asiatica* Vestergr. Site 7: 980 m, dwarf willow slope, July 5, 1972, *247*; site 7: 710 m, willow stream channel, July 10, 1972, *257*; site 9: 970 m, sedge slope, July 13, 1972, *17D*; site 9: 1000 m, sedge slope, July 13, 1972, *17D*; site 9: 1030 m, sedge meadow, July 13, 1972, *17D*; site 16: 650 m, willow stream channel, August 12, 1972, *309*. The two northern Yukon collections plotted by Hultén (1968) were both from the Arctic Coast.

Veronica wormskjoldii Roem. & Schult, ssp. *wormskjoldii* (*V. alpina* var. *unalaschcensis* Cham. & Schlecht.). Site 6: 400 m, snow-bed, July 14, 1971, *5S*. This species is new to Zone 2 of Porsild and Cody (1968) and to the northern Yukon.

Synthyris borealis Pennell. Site 8: 1050 m, polygonal ground, July 10, 1972, *254*. In the Yukon this species is not otherwise known from north of 65° N (Hultén 1968), but it has recently been reported

from the Richardson Mountains of Mackenzie District by Cody and Porsild (1968).

Pedicularis capitata Adams. Site 7: 980 m, dwarf willow slope, July 5, 1972, *247*; site 7, 670 m, willow-dwarf birch, July 11, 1972, *263*; site 16: 650 m, *Dryas-Cassiope* ridge slope, August 10, 1972, *305*. These and the specimens cited by Welsh and Rigby (1971) bring the northern Yukon distribution, as given by Hultén (1968), farther south.

Pedicularis oederi M. Vahl. Site 7: 980 m, dwarf willow slope, July 5, 1972, *247*. This species was reported as new to the Continental Northwest Territories on the basis of a specimen collected in the Richardson Mountains by J. A. Calder (Cody and Porsild 1968). This collection, also from the Richardson Mountains, helps complete the known Yukon distribution. The specimen collected by Welsh and Rigby (1971) falls within the range predicted by Hultén (1968).

Campanula uniflora L. Site 13: 580 m, rock outcrop, June 29, 1972, *7H*; site 21: 520 m, *Dryas* rock outcrop, July 19, 1972, *271*. This species is new to the flora of northern Yukon, but known from adjacent northern Alaska and Mackenzie District (Hultén 1968).

Aster alpinus L. ssp. *vierhapperi* Onno. Site 10: 710 m, gravel ridge, July 9, 1972, *4H*. This is a northward extension of the known distribution in the Yukon Territory from south of 63° N.

Erigeron philadelphicus L. Site 14: 270 m, riverbank, August 14, 1971, *9OCR*. This is apparently an extremely rare plant in the Yukon Territory; Hultén (1968) has only plotted a specimen from the vicinity of Old Crow, from the same vicinity as the specimen cited here, and one from the British Columbia border in southeastern Yukon.

Artemisia alaskana Rydb. Site 9: 710 m, sedge slope, July 13, 1972, *17D*. *Artemisia alaskana* was recently reported as new to the flora of Continental Northwest Territories on the basis of a specimen collected in the Richardson Mountains by J. A. Calder (Cody and Porsild 1968). This specimen and that given by Welsh and Rigby (1971) document the species in northern Yukon.

Artemisia globularia Bess. Site 19: 430 m, *Dryas*-lupine meaow, July 21, 1972, *264*. This specimen represents an eastward extension of the known range of this Amphi-Beringian species from about longitude 150° W; it is thus new to the flora of the Yukon Territory.

Senecio fuscatus (Jord. & Fourr.) Hayek (*S. lindstroemii* (Ostenf.) Porsild). Site 6: 400 m, hummocky tundra, July 17, 1972, *111*; site 7: 980 m, dwarf willow slope, July 5, 1972, *247*; site 9, 1000 m, short shrub, July 13, 1972, *17D;* site 9: 1030 m, short shrub, July 13, 1972, *17D*; site 9: 1050 m, short shrub, July 13, 1972, *17D*; site 10: 710 m, sedge–willow slope, July 9, 1972, *4H*. These specimens extend the range south of the collection areas of Welsh and Rigby (1971) and the predicted range of Hultén (1968).

Crepis elegans Hook. Site 10: 400 m, willow–grass–poplar on gravel, July 5, 1972, *246*. This collection from near the Yukon–Mackenzie District border is an extension of range eastward in northern Yukon from longitude 140° W. The record for Zone 3 in Porsild and Cody (1968), which was based on a specimen collected along the Anderson River, is not shown on the map in Hultén (1968).

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Recent Changes in Chronology of Spring Snow Goose Migration from Southern Manitoba

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Abstract. The earliest, average, and latest dates of major spring migration of Snow Geese (*Chen c. caerulescens*) from southern Manitoba in the period 1953–1972 were 4, 4.6, and 6 days later, respectively, than in the period 1927–1937. These changes are discussed in relation to changes in climate, and in breeding and staging distribution. Changes in breeding distribution were probably most important.

Introduction

In spring 1970, 1971, and 1972, I worked at Winnipeg International Airport to develop techniques for preventing collisions between flocks of Snow Geese (both color phases of *Chen c. caerulescens*) and aircraft (Hunt and Blokpoel 1973; Blokpoel, in press). This work prompted me to research the dates when Snow Geese migrated in large numbers over Winnipeg and vicinity. This note documents recent changes in the chronology of the spring migration of Snow Geese from southern Manitoba.

Methods

Observations of major waves of migrating Snow Geese in the Winnipeg area for the period 1953–1969 were obtained from various sources (Table 1).

For the period 1970–1972 migration records were obtained by making 16-mm time-lapse films, 24 hours a day, of the screen of the master scope of the 23-cm AASR-1 surveillance radar (range set at 60 nautical miles or 111 kilometers) at Winnipeg International Airport, using the film technique described by Solman (1969). In addition, personnel in the field made routine visual observations of staging and migrating geese. Non-routine observations were received from volunteers (game officers, bird watchers, Royal Canadian Mounted Police).

The nomenclature used in this paper follows the checklist of the American Ornithological Union (Committee on Classification and Nomenclature 1973).

Results

Dates of "major migration" from southern Manitoba are given in Table 1. The Winnipeg area is defined as a circle of a radius of 111 km with Winnipeg Airport at the center to coincide with the area scanned by the surveillance radar. "Major migration" has the following meaning:

(*a*) 1927–1937, "the principal migration of the flocks from southern Manitoba" (i.e., from their staging area near Grants Lake, about 48 km northwest of Winnipeg), and the birds involved were "Blue Geese (in association with Lesser Snows)" (Soper 1942).

(*b*) 1953–1969, major migration across the Winnipeg area. In cases where numbers were given, the daily total was at least 15 flocks or 3,000 birds. In other cases I accepted authors' statements (such as "main flight," "heavy migration," "mass movement") as evidence for "major migration."

(*c*) 1970–1972, major migration across the Winnipeg area. The daily total of "goose echoes" (echoes caused by flocks of migrating Snow Geese on the Winnipeg radar screen) was estimated at 200 or more.

Table 1 shows that for the period 1927–1937 only one date per year was given, whereas for the other periods often more than one date

TABLE 1. — Dates of major waves of Snow Goose migration from southern Manitoba. A, visual observations reported by Soper; B, visual observations from various sources; and C, radar data.

Year	Date	Source
A 1927	May 2	Soper (1942)
1928	May 9	” ”
1929	May 8	” ”
1930	May 1	” ”
1931	May 3	” ”
1932	May 10	” ”
1933	May 10	” ”
1934	May 6	” ”
1935	April 28	” ”
1936	May 6	” ”
1937	April 29	” ”
B 1953	May 4, 6	Lawrence (1953); Shortt (personal communication)
1956	May 12, 14	Mossop (1956); Copland (personal communication)
1959	May 7	Mossop (1959); Shortt (personal communication)
1961	May 7, 12, 13	Mossop (1961); Shortt, Smith (personal communication)
1962	May 12, 15	Nero (1962); Logbook Air Traffic Control Winnipeg
1963	May 14	Hosford (personal communication)
1964	May 5, 10	Copland, Hosford (personal communication)
1965	May 10, 11	Hosford (personal communication); Logbook Air Traffic Control Winnipeg
1966	May 16	Gardner (personal communication); Logbook Air Traffic Control Winnipeg
1967	May 11*	Bossenmaier, Gardner, Hosford, Smith (personal communication with Lumsden)
1968	May 9	Gardner, Shortt (personal communication)
1969	May 5, 6, 12	Bidlake, Blanchard, McIvor, Nero (personal communication)
C 1970	May 6, 15, 16, 17	Blokpoel (in press)
1971	May 2, 3, 6, 8, 9, 12	Blokpoel (in press)
1972	May 4, 5, 7, 8, 9, 10	This paper

*Date for peak migration unknown. First flight on May 11; very few birds left after May 17.

per year was reported. For the years with radar data there were even several days with "major migration." This might seem to be the result of the more effective detection of migration by radar. For each of the dates in the 1970–1972 period however (with the exception of May 6, 1970), the "major migration" requirements for visual observations (15 flocks or 3,000 birds) were also met. That so many birds were visually observed may, however, be attributed to the fact that, in contrast to the 1953–1969 period, observations were made routinely and from vantage points (such as the Winnipeg Air Traffic Control tower).

Table 1 also shows the spread in dates: 14 days for 1927–1937, 12 days for 1953–1969, and 16 days for 1970–1972. To make data comparable, 1 day was added for all dates during leap years.

In comparing the results for the period 1927–1937 and 1953–1972, there is a marked trend towards later flights in the more recent years: earliest, average, and latest dates of major flights differed by 4, 4.6, and 6 days, respectively. The difference in averages for the two periods was statistically significant ($P < 0.01$; t-test with unequal sample sizes).

Discussion

Only for the period 1970–1972 do I have complete data, i.e. dates when the geese were and were not flying. Data for 1953–1969 are incomplete in the sense that there is a record only for an unknown portion of those days that had heavy migration. Soper's (1942) data for 1927–1937 were probably similarly incomplete, although in that period the geese may have migrated in one single flight rather than in two or more waves.

Hochbaum (1971), summarizing data for the period 1952–1963 for the Delta Waterfowl Research Station (some 80 km northwest of Winnipeg), mentioned "Mass migration of Blue Geese and Lesser Snow Geese to their Arctic breeding grounds: May 7 – May 15."

The spread in migration dates from year to year within a decade may probably be explained in terms of availability of food, presence of

sheetwaters, history of the weather on the staging grounds, and possibly even the breeding success during the previous year (F. G. Cooch, personal communication).

The difference between the dates for 1927–1937 and 1953–1972 may have been caused by changes in climate, changes in the distribution of breeding colonies, and changes on the staging grounds.

Changes in Climate

According to Lincoln (1950), the spring migration of Canada Geese *Branta canadensis* advances with the 35°F isotherm, which ". . . appears to be a governing factor in the speed at which these geese move north, and over their entire trip the vanguard follows closely the advance of this isotherm." Assuming that the Snow Goose migration is affected by temperature in a similar way, one would expect that a climatic change resulting in lower temperatures on the staging grounds would delay the advance of the geese.

The last staging area of the Snow Geese before their flight to the coasts of James and Hudson Bays used to be Grants Lake, 48 km northwest of Winnipeg (1927–1937) (Soper 1942), but during the 1953–1972 period the main concentrations were seen in the Pilot Mound – Snowflake area in southwestern Manitoba along the international border (Blokpoel, in press). I have no temperature records for these staging areas, but the weather data for Winnipeg would certainly reveal any climatic change in southern Manitoba.

Mean daily temperatures for the months of April and May during the period of 1953–1972 (37.40°F and 51.23°F) were slightly lower than during 1927–1937 (37.88°F and 52.95°F) (see Table 2A).

During the last century the daily mean temperature has fluctuated but shown no persistent

TABLE 2. — Mean daily temperatures for April and May for Winnipeg.

Years	April			May		
	Mean	Standard deviation	Number of years	Mean	Standard deviation	Number of years
A 1927–1937	37.88	3.70	11	52.95	3.40	11
1953–1972	37.40	4.13	20	51.23	3.17	20
B[1] 1872–1880	34.29	5.62	9	52.96	2.62	9
1881–1890	35.61	4.02	10	50.01	4.64	10
1891–1900	39.05	6.42	10	52.32	3.16	10
1901–1910	38.28	5.75	10	51.38	4.95	10
1911–1920	40.08	5.57	10	52.99	2.77	10
1921–1930	39.07	3.67	10	52.56	4.80	10
1931–1940	36.99	2.95	10	53.93	2.49	10
1941–1950	38.26	4.93	10	50.72	4.07	10
1951–1960	38.73	5.76	10	52.42	3.25	10
1961–1970	36.97	3.68	10	50.12	2.27	10
1971–1972	37.75	0.07	2	54.25	5.73	2
C[2] 1938 (St. John's College)	37.8	–	–	51.9	–	–
1938 (Winipeg Airport)	38.0	–	–	51.2	–	–

[1]1872–1938 temperatures measured at St. John's College, Winnipeg. 1939–1972 temperatures measured at Winnipeg International Airport.

[2]The only year that temperatures were measured at both Winnipeg stations.

trends (Table 2B). The data in Table 2B are not strictly comparable because of a change in the location where the temperatures were measured (Table 2C) and the increasing urbanization of Winnipeg. In summary, the data in Table 2 indicate no climatic trend with respect to temperature for the Manitoba staging areas during the period 1927–1972.

One might theorize that climatic change occurred on the breeding grounds, to which the geese adapted by delaying their spring migration. During 1927–1937 the majority of the geese bred on Baffin Island (F. G. Cooch, personal communication). An increase in world temperatures (mean annual and particularly mean winter) from the 1880's to the early 1940's has since given way to a moderate cooling trend at most latitudes (Mitchell 1961). As Kerbes (1969) pointed out, however, trends in world temperatures need not necesarily be reflected in weather changes on Baffin Island, where he studied the Koukdjuak Plain colony of Snow Geese. He noted that the mean annual temperatures for the period 1943–1960 for Frobisher Bay (320 km southeast of the colony, and the nearest weather station with a long run of records) did not suggest a trend of any kind.

Bradley and Miller (1972) found no evidence of the global cooling trend on Baffin Island either. On the contrary, they found that during the period 1960–1969 the mean annual temperatures increased, as a result of a decrease (by as much as 2.1° C) in mean temperature during the ablation season (June to August, when glaciers are reduced) and an increase (by as much as 2.0°C) in the mean temperature in the much longer accumulation season (September to May, when glaciers increase in size). They also observed an increase in precipitation during the accumulation season. These changes resulted in an increase of permanent snowbanks, incipient glaciers, and the duration of ice cover on small lakes. Such changes are very unfavorable for the breeding success of the Snow Goose. The Snow Geese might adapt to this climatic trend by arriving later at the breeding ground through postponing their migration (which might in turn explain the later migration dates in more recent years). The data in Table 1 do not support this hypothesis: during the 1960–1969 period there was no trend to later dates to accord with the trend to lower summer temperatures.

The Snow Goose breeding season on Baffin Island is the shortest season of all colonies (F. G. Cooch, personal communication), and any further deterioration of the conditions on the breeding grounds may well result in repeated breeding failures or the selection of other breeding sites and thus, in either case, in the eventual disappearance of the Baffin Island breeding colonies.

Changes in Distribution of Breeding Colonies

The principal change in the breeding distribution of the eastern populations of Snow Geese in the last 30 years is the foundation and/or rapid growth of colonies on the west coast of Hudson Bay (R. H. Kerbes, personal communication). The breeding colonies on Baffin and Southampton Islands are decreasing in relative importance. The presence of the newly-founded colonies on the west coast of Hudson Bay may help explain why in the period 1953–1972 often more than one migration wave was observed, while this was never recorded for 1927–1937. This development may well have had an influence on the dates of migration waves. Because of the comparatively long breeding season at the Hudson Bay west coast the geese can avoid the hazards associated with very early spring (snow storms, etc.) by arriving late, and yet bring off their broods successfully.

The increase of the size of the McConnell River colony on the west coast of Hudson Bay has been phenomenal, and it would seem interesting to know to what extent this growth has been influenced by local climatological changes and/or immigration from Southampton Island or Baffin Island colonies. A report to document and explain the growth of this colony is in the planning stage (R. H. Kerbes, personal communication).

The influence of climate on distribution and migration of birds has been studied by many authors, particularly in Europe, and was recently reviewed by Schüz (1971).

Changes on the Staging Grounds

Before their flight over Winnipeg towards James and Hudson Bays, the geese stage in northern North Dakota and southwestern Manitoba for a few weeks. The presence of food and undisturbed roost areas (such as sheetwaters) are the factors that largely determine their distribution on the northern prairies. It is conceivable that changes in the amount of sheetwater (possibly the result of changes in the local climate and in drainage systems) and changes in food availability (as for example by increased fall tillage) have changed the migration chronology.

Conclusion

If the Snow Geese have indeed migrated at later dates in more recent years, it is likely that this was mainly owing to the change in breeding distribution.

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Notes

Ground Nesting of Bald Eagles near Yellowknife, Northwest Territories

From 1968 to 1973, we conducted an annual survey of breeding birds on the West Mirage Islands (62°16′ N, 114°29′ W), Great Slave Lake, Northwest Territories. During this period, we observed the construction and use of a ground nest by a pair of Bald Eagles (*Haliaeetus leucocephalus*). The West Mirage Islands consist of a discrete complex of approximately 100 rocky islets and islands in Great Slave Lake about 13 miles SSW of Yellowknife, N.W.T. A detailed description of the avifauna and habitats found on these islands was recently published by Weller et al. (1969).

Ground Nesting

During a visit to the islands in early July 1970, Bald Eagles were frequently observed near a frail nest-structure located near the top of a dead 30-foot spruce tree on a 1½-acre island. Remnants of an old nest, apparently blown down during the previous winter, were scattered below the tree. The reconstructed nest in the tree contained new nesting material but no eggs.

While searching for duck nests on adjacent islands on 3 July 1970, we found an eagle's nest platform on the ground of a 1-acre island about 300 yards from the tree nest. The ground nest was

FIGURE 1. Ground nest constructed by Bald Eagles on West Mirage Islands, N.W.T. Note the extensive area of the nest and its proximity to water.

located about 60 yards from a small grove of trees on a low, flat, rocky peninsula. The nest was constructed about 5 feet above and 15 feet from water (Figure 1). The nest, built largely of driftwood up to 2 inches in diameter, had dimensions of 4 feet by 6 feet. About three-fourths of the nest was lined with a thick mat of dead grass and moss. No eggs were laid in this nest during 1970.

On 23 June 1971, two Bald Eagles were observed on the island with the tree nest. This nest had been completely rebuilt and contained two eaglets estimated to be 2 weeks old. By 13 August, the young were nearly grown but unable to fly. The ground nest found in 1970 on the adjacent island showed no evidence of use by eagles in 1971.

When the islands were visited on 22 July 1972, the tree nest had blown down again. A new nest, 18 inches in diameter, was constructed in the same tree but contained no eggs or young, however, two eaglets about 5–6 weeks of age were observed in the ground nest on the adjacent island (Figure 2). The ground nest had been enlarged and now measured 5 feet by 8 feet. An adult eagle was sighted near the nesting islands.

On 5 July 1973, two adult Bald Eagles were again observed near the nesting islands. In the ground nest, two eaglets approximately 4 weeks old were found. Ice during the spring breakup, or water during a recent storm, had eroded away about one-fourth of the ground nest. Litter from a winter camp was found on the adjacent island below the tree nest. The spruce bough supporting the nest and considerable nesting material had been used for firewood.

FIGURE 2. Two 5- to 6-week-old Bald Eagles observed in ground nest on West Mirage Islnads, N.W.T. Note the nearby tree and higher rocks in the background.

Nesting History

While this is the first known ground nest of Bald Eagles on the West Mirage Islands, eagles have a long history of nesting on the islands. The late William L. McDonald, a geological consultant and amateur ornithologist, first recorded a Bald Eagle nest in the same 30-foot spruce tree on the West Mirage Islands in 1929. McDonald observed the eagles' occupancy of this nest site over the years. He also noted occasional destruction of the nest, young, and adults by local fishermen, who considered the eagles detrimental to the fishing industry. McDonald's observations established that Bald Eagles had a nesting tradition on the West Mirage Islands spanning several decades.

Based on the initial survey of the West Mirage Islands (Weller et al. 1969), Bald Eagles were considered rare breeding birds or summer residents. Eagles were not observed on the islands in 1968, but the old tree nest and several feathers were found. In July 1969, we observed a pair of eagles carrying nesting material to the tree nest. One bird had typical adult plumage, but the other had several dark feathers on its head indicating that this individual may not have attained maturity. These birds did not lay eggs on the islands in 1969.

Discussion

Bald Eagles typically nest in tall trees near large lakes and along the shore of Great Slave Lake in the Yellowknife region. Godfrey (1966, p. 97) stated that this species generally nests near the top of trees and only rarely on cliff ledges.

Few specific references to ground-nesting eagles exist in the literature. Bent (1937, p. 335) concluded that Bald Eagles may nest on rocky cliffs or pinnacles of rock in treeless areas. He cited Gianini (1917, p. 400), who found several nests on cliffs and buttes along the coast or near rivers of the Alaska Peninsula. Bent (1937) also referred to Preble's observations of cliff-nesting Bald Eagles along lake-shores in northern Canada. In general, published accounts emphasize the fact that Bald Eagle nests on the ground usually are situated on rocky promontories where suitable trees are unavailable for nesting.

The ground nest of Bald Eagles on the West Mirage Islands is unique in that it was situated on a low rocky peninsula only a few feet above water. The nest site was not located on the highest point of land on the island and was near trees. Perhaps the frequent destruction of the tree nest contributed to the construction of a more secure nesting site.

The tenacity of the Bald Eagles for a specific nesting site is also of considerable interest. Eagles have attempted to nest in the same tree for more than four decades. Although the ground nest was used as an alternate nesting site, the eagles have persisted in reconstructing the tree nest. But there are many trees that appear suitable for nesting on other islands of the West Mirage complex and along the shore of Great Slave Lake. We could only speculate on the mechanisms of habitat selection and lineal relationship of the eagles nesting on the islands.

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Range Extension of the Ring-necked Duck, *Aythya collaris*, into Labrador

Interest in the waterfowl productivity of Labrador-Ungava was renewed in 1970 largely because of the Churchill Falls (Labrador) Corporation's hydro-electric power development in western Labrador. The reservoir (3,400 square miles) being created by the project will flood a large proportion of western Labrador's marsh and bog complexes. Co-operative studies by the Canadian

Wildlife Service and the Newfoundland and Labrador Wildlife Service have produced information on less common species such as the Ring-necked Duck, *Aythya collaris*. We have observed that the Ring-necked Duck has extended its breeding and post-breeding ranges to the northeast and now is found in much of Labrador.

The known eastern breeding limits of the Ring-necked Duck appear to have been restricted to southwestern Ontario, northeastern Minnesota, and eastern Wisconsin prior to 1925 (Mendall 1958). By 1936, there was evidence that the species had extended its breeding range into northern Maine (Swanson 1937) and in 1939 it was established as a breeder in Prince Edward Island (Peters 1941). Tuck (1949) reported a further eastward extension of the range on the basis of two broods he observed near Gander, Newfoundland. Cooch (1955) made the first factual record of breeding ring-necks along the north shore of the Gulf of St. Lawrence. He captured two downy young on the Piashti River, 6 miles inland from Baie Johan Beetz in August 1950. C. E. Addy observed a pair of ring-necks in southeastern Labrador (53°00′ N, 59°00′ W) in June 1952 that appeared to be breeders (Todd 1963).

A total of 74 Ring-necked Ducks, 59 adults and 15 downy young, was observed at 31 sites during our surveys of Labrador-Ungava in 1970 and 1971 (Figure 1). Each of the three broods had five young. The most northerly and easterly sighting was southwest of Hopedale, Labrador (55°00′ N, 61°10′ W).

Mendall (1958) in his description of Ring-necked Duck habitat stated, "Bogs are especially favoured, both in the north and in the south, particularly those of the so-called 'quaking marsh' or floating island type." Most of the ring-necks seen on our surveys were in string-bogs which consist mostly of shallow acidic pools with black organic ooze bottoms. In and among the pools are strings of vegetation, largely sphagnum moss (*Sphagnum* spp.) with a few shrubs and sedges, particularly Labrador tea, *Ledum groenlandicum,* and bulrush, *Scirpus hudsonianus.* Stunted black spruce, *Picea mariana,* and tamaracks, *Larix laricina,* also grow on the strings.

Mendall (1958) suggested that Labrador offered very little suitable habitat for ring-necks. Hare (1959), however, indicated that about 20,000 square miles north of 51°30′ N in Labrador-Ungava are bogs similar to that described above. More than half of this cover-type is located in Labrador and the major areas have already been occupied by Ring-necked Ducks: the Lobstick–Michikaman Lake bog-complex and the Lac Joseph bog-complex.

Hare (1959) also described a major area of bog in the vicinity of Ossokmanuan Lake, located between the two previously-mentioned areas. That habitat has been lost with the construction of the hydro-electric complex at Twin Falls in 1962. Mendall (1958) considered the regulation of water levels critical for the management of waterfowl. Fluctuations as small as 6 inches during the nesting period can cause nesting failures. The Ossokmanuan reservoir, which experiences fluctuations of several feet during the spring and summer, cannot support waterfowl nesting. Most of Labrador's prime Ring-necked Duck habitat will be lost with the creation of the Lobstick–Michikaman reservoir for the Churchill Falls development, which will have fluctuations of 27 feet. Thus, the Ring-necked Duck has extended its range north into Labrador, but numbers will be restricted by limited habitat and hydro-electric development.

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Noteworthy Summer Observations of Birds in the Caribou Mountains, Alberta

In June 1973, we made a reconnaissance of the birds and mammals of the Caribou Mountains northeast of the settlement of Fort Vermilion, Alberta. An account of our findings is to be published later, but our most noteworthy observations of birds are reported here.

Rather than a mountain range, the Caribou Mountains are a lake-studded plateau extending for about 90 miles east to west and about 70 miles from north to south. A considerable portion of this plateau rises above 3,000 feet, i.e. 2,000 feet above the adjacent valleys of the Hay and Peace Rivers. The area is bordered by Wood Buffalo National Park to the north and east.

On June 9 we found two Red-throated Loons (*Gavia stellata*) idly swimming together as an apparent pair on an unnamed lake one-quarter to one-half mile long, 1½ miles northeast of the fish camp on the west end of Margaret Lake. The latter is the largest of the lakes of the plateau; it lies approximately in its center and is named on all appropriate maps. On our walk back to the fish camp along a seismograph trail we came across another of these loons on a puddle in the wide trail. The loon was unable to take off from there and was easily captured, photographed, and then carried to Margaret Lake where we released it.

On our second stay in the Caribou Mountains we camped, from June 26–28, on Rock Island Lake (a local name not yet used on maps) about 10 miles northeast of the western end of Margaret Lake. Throughout our stay one or two Red-throated Loons were visible from our camp. They kept mostly to the bay on the western shore of the lake where the creek which drains it takes origin and where there is a stretch of grass-sedge marsh. We explored this marsh only along one shore of the deep creek, and during this time both loons kept well out on the water.

On June 29 we revisited the small lake near Margaret Lake where we had seen two of these loons earlier in the month, confidently expecting to find them again, perhaps with young. On this occasion, however, although we walked around the entire lakeshore, only a single Common Loon (*Gavia immer*) was seen on this lake.

We presume the loons seen here earlier were still en route to their breeding grounds, but the presence of two others on Rock Island Lake late in June strongly suggests that the species breeds on some of the lakes of the Caribou Mountains.

On June 30, while walking along the shore of a larger (about a mile long) unnamed lake which lies a mile due east of the Margaret Lake fish camp, we heard the characteristic spring call of a male Oldsquaw (*Clangula hyemalis*). Soon a male and female of these birds, the male in full breeding plumage and still calling, flew past us parallel to the shore, about 35 yards away. These birds were so far from the known nesting areas of their kind that we presume they were destined to be non-breeders during the season in question and had not completed their spring migration.

On June 28 we walked to an unnamed lake about one-quarter mile long which lies a mile west of the shore of the most northern bay of Rock Island Lake. The north shore of this small lake has what is for this area an extensive grass-sedge marsh. As we followed the shore along this a small shorebird, twittering vigorously, suddenly flew out of the marsh at, and then around us. When it returned to the water it was easily identified as a Northern Phalarope (*Lobipes lobatus*) in breeding plumage though we could not determine its sex. It repeated its apparently anxious flights around us broken by returns to the water, during which it came close enough to one of us at times to be photographed, and it followed us behaving in this manner for a full quarter mile of the lakeshore. Its behavior suggested that it had young nearby.

The only geographically comparable breeding record of which we are aware is that of Nero (1963). It refers to an area in Saskatchewan south of Lake Athabasca which actually lies somewhat further south than the Caribou Mountains.

Throughout our stay on the west shore of Rock Island Lake, from the evening of June 26 to that of the 28, Gray-cheeked Thrushes (*Hylocichla minima*) were seen and heard singing. A male was collected there on June 27 and the specimen is to be given to the Alberta Provincial Museum in Edmonton. Several pairs of these thrushes were in old burns which constituted open areas with only a scattering of young spruce and occasional stands of more mature trees to the west and northwest of our camp, and others were seen

along the creek which drains Rock Island Lake. Several were seen with food in their beaks and this, as well as their behavior, suggested they had young nearby. About Rock Island Lake they were, apart from Robins (*Turdus migratorius*), the only thrushes detected, while farther south about Margaret and Eva Lakes, Hermit Thrushes (*Hylocichla guttata*) and Robins were the only thrushes found.

Our observations indicate a breeding population of Gray-cheeked Thrushes in the northern part of the Caribou Mountains. A glance at the map of the breeding range of the species in Godfrey (1966) shows that this represents a significant addition to its known breeding distribution. The Caribou Mountain population of this thrush is almost certainly an isolated one, the altitude of the "mountains" providing the environmental factors required by the birds, for Soper (1942) did not see even one of these birds during his two-year stay in Wood Buffalo Park.

We should like to express our gratitude to Mr. George Grimm, owner of the Margaret Lake Fish Camp, for his hospitality.

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Growth of the Eye Lens and Its Use as an Age Index for a Population of Wild Black-tailed Deer on Vancouver Island, B.C.

Abstract. The growth of the eye lens was studied in a population of wild black-tailed deer (*Odocoileus hemionus columbianus* Richardson) on Vancouver Island, British Columbia, in 1968, for purposes of age determination. Significant associations between increasing weight of the lens and age of the deer are described. Because of the variation among individual lens weights, however, mathematical expressions generated by the computer failed to give reliable estimates of age. As a consequence, age determination by subjective analysis of tooth eruption and wear patterns is suggested to be equally reliable.

Introduction

Assigning animals to age classes is essential for demographic analysis of wildlife populations. To meet this end, several growth parameters have been studied as age indicators for wildlife populations (Klevezal' and Kleinenberg 1969). Since the report of Lord (1959) that the eye lens of the cottontail rabbit (*Sylvilagus floridanus*) could be used as a reliable index to age, much emphasis has been devoted to this structure as an age criterion for other wildlife species (Friend 1968). The purpose of this study has been to describe the growth of the eye lens for a population of black-tailed deer on Vancouver Island, British Columbia, and to define its limitations in age determination. The study was jointly sponsored by a scholarship from the National Research Council of Canada 1968–1970, and a grant from the British Columbia Department of Recreation and Conservation.

Methods and Materials

Eyeballs and lower jaws from 232 hunter-killed deer were collected at a game check during the 1967–1968 hunting season in the Cowichan Lake watershed on Vancouver Island, B.C. All jawbones were classified into age classes according to the number of annulations counted within the cementum of the sectioned incisors (Low and Cowan 1963). The eyeballs were collected from the carcasses in a manner similar to that described by Friend (1967, 1968); they were injected with 10%

formalin until turgid, and left in the solution for a period of 90 days. One week prior to termination of the fixation period, the hardened lenses were removed and cleaned. The lenses were then put into stoppered 3-dram shell vials containing 10% formalin until termination of the treatment. At 90 days, all lenses were removed, hand-dried with tissues, and immediately weighed to the nearest 0.1 mg on a Mettler analytical balance to offset desiccation effects. Any discolored and damaged (because of handling) lenses were discarded.

Results

A difference in the weights of the right and left lenses was found for individual deer but neither lens was significantly heavier than the other. The right lens was heavier in 50% of the males and 49% of the females sampled. The left lens, on the other hand, was heavier in 43% of the males and 51% of the females sampled. Of the total sample, only 6% of the animals had paired lenses of equal weight.

The mean weights of the right and left lenses did not differ significantly for deer of the same sex and age class ($P > 0.05$). Similarly, the mean lens weights for deer of the same age group but opposite sex were not significantly different ($P > 0.05$). But the mean weights of the lenses for consecutive age classes were significantly different and described a curvilinear relationship with age (Figure 1). The data were subsequently fitted to common logarithmic and arithmetic regression models. All ages were increased by a factor of 7 months (the approximate gestation period for the species) to avoid problems of negative values in the analysis (Kolenosky and Miller 1962; Longhurst 1964). Of the many alternatives, one gave what appeared to be the best representation of the increasing lens weight - age relationship,

$$\text{Log } Y = 2.644 + 0.257 (\text{Log}(X + 7))$$

where $(X + 7)$ represents the age of deer in months postpartum, and Y is the weight in milligrams of the individual lens.

Inspection of the graph (Figure 2) suggested that a better fit of the data was possible. Using the IBM system/360 Scientific Subroutine Package, the data were fitted to higher polynomial expressions. Individual lens weights were so variable among all age classes, however, that the analysis failed. But when the mean weights of the lenses for age classes were substituted in the program, a fourth-degree polynomial was generated for the data with significant reduction in deviations from the linear and simple polynomial regressions:

$$Y = -111.15 + 340.89X - 335.82X^2 + 109.29X^3 - 0.45X^4.$$

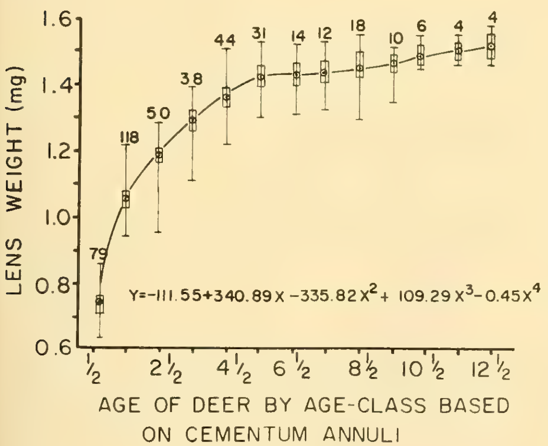

FIGURE 1. Growth curve for the eye lens of black-tailed deer on Vancouver Island, British Columbia. Horizontal lines represent the range of the lens weights for each age class about the mean lens weight (circled). The small rectangles represent the 95% confidence intervals about the circled means. The small numbers above the curve represent the sample sizes within each age class.

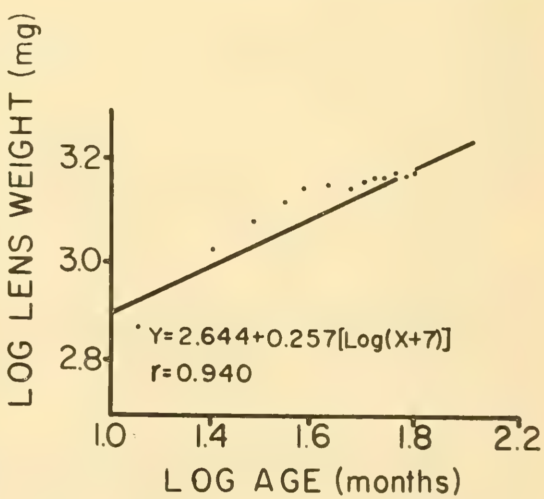

FIGURE 2. Linear regression of lens weights on age of black-tailed deer. Age is estimated from counts of cementum annuli and includes the 7-month correction for the period of gestation.

Discussions and Conclusions

The data collected in this study were based upon random samples of a natural population in which the animals' ages were not known beforehand. Nevertheless, counts of tooth annuli are believed to give absolutely accurate age determinations for known-age wild deer on Vancouver Island (Thomas and Bandy 1973). Therefore, individual lens weights could be easily assigned to specific age groups within the population.

Unlike Longhurst (1964), who claimed success in estimating the age of individual black-tailed deer to 5 years of age by regressions of lens weights on age, we found that the mathematical expressions generated in this study did not serve to give reliable estimates of age for this population. Individual lens weights were so variable that linear models, although significant, were mostly impractical for inferences of age. Moreover, in attempting to minimize this variation by considering the mean lens weights for all age classes only, the polynomial expressions were impractical for age determination as well, as no confidence could be placed on the final estimates.

At best then, the lens-weight method permits reliable separation of the fawn and adult classes only (cf. Lueth 1963). To place further emphasis on this growth structure as an age criterion for this population would be foolhardy where subjective characteristics of tooth eruption and wear serve equally well (Child 1970). Nevertheless, it has been shown that the eye lens grows continuously at a species-predictable rate, and the resultant growth curve awaits verification when tagged specimens of known age become available.

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Albino Little Brown Bat (*Myotis lucifugus lucifugus*) from Wisconsin, with Remarks on Other Aberrant Bats

In a recent publication (Walley 1971) I reviewed most of the literature on albinism and other aberrant colorations in bats, but I omitted five important references which are cited below, along with information on an albino Little Brown Bat (*Myotis l. lucifugus*) from Wisconsin.

Hamilton (1930) reported an occurrence of pied coloration in bats, and sited a specimen of *M. l. lucifugus* from Kentucky. Trapido and Crowe (1942) sited two additional specimens of *M. lucifugus* showing pied patterns from Pennsylvania and New Jersey, and three leucistic *Eptesi-*

FIGURE 1. Albino *Myotis l. lucifugus* from Wisconsin. Photo by Jane K. Glaser, RBP, Northern Illinois University.

cus fuscus from Pennsylvania and New Jersey. Subsequently Goslin (1947) reported a leucistic *Pipistrellus s. subflavus* from Ohio, having only the wing tips white, while Bures (1948) reported an albinistic specimen from Maryland. Sealander (1960) recorded color variants in *Myotis sodalis* from Arkansas.

While leucistic patterns appear somewhat regularly in certain species of bats (*Tadarida brasiliensis, Myotis sodalis,* and *Barbastella barbastellus*), albinism is rarely reported.

Dubkin (1952) described the first reported albino *M. lucifugus* at length, while the present report apparently represents the second known specimen.

The present specimen, FMNH 44435, male, was collected by Mrs. J. Hinaus in July 1936, at Bruce, Rusk County, Wisconsin, and presently is in a mummified state of preservation. The forearm measures 36.8 mm, ear 9.4 mm, foot 10.2 mm, whereas body measurements of this specimen could not be made accurately (Figure 1). The spinal column is clearly visible through the white pelage.

To my knowledge this represents the second reported albino *M. lucifugus,* as well as a new county record for this species in Wisconsin.

I thank Mr. Richard Stupka, Northern Illinois University, DeKalb, for bringing this specimen to my attention, and Dr. de la Torre of the Field Museum of Natural History, Chicago, for permitting examination of it. I am grateful also to Mrs. Jane K. Glaser, Department of Biology, Northern Illinois University for supplying the photograph.

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Rediscovery of the Rock Vole (*Microtus chrotorrhinus*) in Minnesota

The rock vole, *Microtus chrotorrhinus,* has long been included on lists of Minnesotan mammals, on the basis of a single specimen taken by Vernon Bailey in 1921 at Burntside Lake in St. Louis County. Swanson (1945, pp. 90, 92) reported a vole obtained at Ely by Shaler Aldous in 1940 as of this species, but Handley (1954, p. 260) re-identified it as a heather vole, *Phenacomys intermedius.* Subsequently, these two specimens have remained the only records of the two species in the state. Thus, more than 50 years have elapsed since the rock vole has been detected in Minnesota.

Two *Microtus chrotorrhinus* were trapped on 9–10 August 1973 at 17 mi N, 1 mi W Grand Marais, NW ¼ sec 29, T 64 N, R 1 E, elevation 1758 feet, Cook County, Minnesota, which is approximately 75 miles east of Burntside Lake. Both specimens were taken in association with a long narrow bed of boulders deposited by the Rainey Lobe of Wisconsin glaciation (9,000–10,000 years Before Present. Grout et al. (1959, p. 114) described this particular rock stream, the largest in the county, as consisting of boulders of granophyre and gabbro. Dominant vegetation near the center of the bed consisted of dry lichens that covered the boulders, and reindeer "moss" (*Cladonia*). Balsam fir (*Abies balsamea*), black spruce (*Pisea mariana*), white cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), *aspen* (*Populus*), paper birch (*Betula papyrifera*), mountain maple (*Acer spicatum*), prickly rose (*Rosa acicularis*), blueberries (*Vaccinium*), and red raspberries (*Rubus strigosus*) grew among the moss-covered rocks near the edge of the rock stream. The adjacent forest community also included thimbleberry (*Rubus parviflorus*), bunchberry (*Cornus canadensis*), Clinton's lily (*Clintonia borealis*), and clubmoss (*Lycopodium*). In some places, boulders covered with moss and leaf litter extended well into the dense forest.

The first rock vole was captured on the evening of 9 August in a trap set on the forest floor approximately 25 feet from the open rocks. The second was trapped during the early morning hours of 10 August at a hole between two large boulders near the edge of the rock stream and forest. Both were captured in Museum Special snap-traps baited with a mixture of peanut butter and rolled oats. The vole taken on 9 August was a lactating female (MMNH 12266) with placental scars of two age groups: new scars IL-2R and old scars 2L-2R. The second (MMNH 12267) was a non-breeding, subadult male with testes 3 by 4 mm. Neither animal displayed evidence of molt. Ectoparasites collected from the two rock voles include fleas (*Peromyscopsylla catatina* and *Megabothris quirini*), mites (*Laelaps alaskensis* and *Laelaps kochi*), ticks (*Ixodes angustus*), and chiggers (*Trombiculidae*).

External and selected cranial measurements (all in millimeters) for the female and male are as follows: total length, 160, 132; length of tail vertebrae, 46, 40; length of hind foot, 21, 19; height of ear from notch, 16, 15; greatest length of skull, 26.1, 24.3; zygomatic breadth, —, 14.2; alveolar length of upper toothrow, 6.3, 5.6; least interorbital constriction, 3.5, 3.6; length of nasals, 7.4, 6.6. Weights were 33.0 g and 21.8 g, for the female and male, respectively.

In addition to the two *Microtus chrotorrhinus,* one *Sorex arcticus,* two *Sorex cinereus,* four *Blarina brevicauda,* three *Eutamias minimus,* two *Peromyscus maniculatus,* seven *Clethrionomys gapperi,* and one *Napaeozapus insignis* were captured in the 167 traps set in this area for 3 days. *Tamiasciurus hudsonicus* was abundant in the surrounding forest. It is noteworthy that *Microtus pennsylvanicus,* an abundant microtine elsewhere in northern Minnesota, was not detected at this locality.

I gratefully acknowledge financial support from the Dayton Natural History Fund of the Bell Museum of Natural History. Elmer C. Birney aided in preparation of the manuscript and Allen H. Benton identified the fleas. Specimens are deposited in the Bell Museum of Natural History (MMNH) at the University of Minnesota.

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First Records of Eastern Flying Squirrel (*Glaucomys volans*) from Nova Scotia

During a study of the mammals of Kejimkujik National Park in southwestern Nova Scotia, two specimens of eastern flying squirrel, *Glaucomys volans* were collected by Wood. A female, containing two embryos measuring 25 mm in length, was taken May 19, 1971 near Grafton Lake, Queens County. A male with turgid, scrotal testes and skull sutures closed was taken on July 4, 1971 near Pebbleloggitch Lake, Digby County. The specimens are now in the National Museum of Natural Sciences, Ottawa (catalogue numbers NMC 39452–3).

The weights of the specimens are (in grams, female then male, respectively) 60.3 and 32.2. External measurements (in millimeters) are as follows: total length, 233, 180; tail vertebrae, 106, 80; hind foot, 30, 29; ear, 17, 19. Cranial measurements are as follows: greatest length, 33.7, 30.6; zygomatic breadth (of female), 20.5; mastoid breadth (of female), 17.2; least interorbital breadth, 7.1, 6.3; length of nasals, 9.4, 6.6; maxillary tooth-row, 6.5, 6.4. Fur on the undersides of both specimens was white basally. A third specimen, a male collected by Cain, Woodworth, and Fancy from the region of the park on July 19, 1967, and identified by pelage characteristics and external measurements as *G. volans,* is in the collection at Acadia University, Wolfville, Nova Scotia (Ma 541). Recorded measurements (in millimeters) of that specimen are as follows: total length, 220; tail vertebrae, 95; hind foot, 27. The skull was not available for examination.

Several records exist of *G. sabrinus* from southwestern Nova Scotia. Sheldon (1936) collected four immatures at Lake Kedgemakooge, Annapolis County, and in 1927 V. E. Gould collected an adult male (UMMZ 81089) in Queen's County (Hooper, personal communication). External measurements are not available, but the skull measurements are as follows: greatest length, 36.1; zygomatic breadth, 23.0; mastoid breadth, 18.2; least interorbital breadth, 7.1; length of nasals, 10.3; maxillary tooth-row, 6.7. In 1969 a park staff member captured a male northern flying squirrel in the park at Jacques Landing, Annapolis County; the external measurements of the squirrel were 264-126-36-21 mm.

Table 1 presents weights, and external and skeletal measurements of 12 specimens of *G. volans* from Ontario and Quebec (NMC: 6975, 11330, 26604, 36100–102, 36279, 36403, 37373–4; ROM: 18053–4), and seven of *G. sabrinus* from Halifax and Colchester Counties in Nova Scotia (ROM: 21910, 21936; NSM: 972-2-301.3, 972-2-309.1-309.4). The specimens of *G. volans* from Kejimkujik National Park differ in all measurements from *G. sabrinus* collected in Nova Scotia, and the male is smaller than the mean size of *G.*

TABLE 1. — Mean weights (in grams) and measurements (in millimeters) of *Glaucomys volans* from Ontario and Quebec, and *G. sabrinus* from eastern Nova Scotia

	Glaucomys volans		*Glaucomys sabrinus*	
	Mean ± S.E. (Number)	Range	Mean ± S.E. (Number)	Range
Weight	52.6±8.3 (6)	46.5–67.3		
Total length	228±7.6 (12)	198–250	264±15.2 (5)	241–275
Tail vertebrae	102±6.7 (12)	80–114	123±7.7 (5)	114–130
Hind foot	31±0.8 (12)	30–33	36±1.3 (5)	35–38
Ear	19±1.0 (7)	18–21		
Greatest length skull	34.6±0.5 (12)	33.4–35.8	36.9±1.0 (6)	35.7–38.0
Zygomatic breadth	20.9±0.5 (11)	19.7–21.7	21.7±0.8 (7)	20.2–22.6
Mastoid breadth	18.5±0.7 (12)	16.2–19.6	18.2±0.9 (5)	17.0–19.0
Least interorbital breadth	6.9±0.4 (12)	6.3–8.9	8.5±1.2 (7)	6.4–9.8
Length of nasals	9.6±0.2 (12)	8.9–9.9	10.1±0.8 (7)	8.8–11.4
Maxillary tooth-row	6.4±0.2 (11)	6.0–6.9	6.9±0.4 (6)	6 4–7.5

volans from Ontario and Quebec. Peterson (1966, p. 132) noted that *G. sabrinus* in Nova Scotia is smaller than elsewhere in Canada. A similar size difference in *G. volans* would not be unexpected; indeed, two of the three specimens collected in Nova Scotia are smaller than the mean measurements of the species from Ontario and Quebec.

These specimens represent the first records of *Glaucomys volans* in the Maritime Provinces of Canada. Previous northernmost records for eastern North America were from Rutland County, Vermont and Hancock, New Hampshire (Hall and Kelson 1959, p. 407). In central Canada the species has been reported from several localities in Ontaria and Quebec (Peterson 1966, p. 129; Youngman and Gill 1968).

Peromyscus leucopus is another mammal that, like *G. volans,* is limited in the Maritimes to southwestern Nova Scotia (Hall and Kelson 1959, p. 629; Wood, unpublished). The distribution of these two species suggests an affinity of the mammalian fauna of southwestern Nova Scotia with that of New England and a difference from that of northwestern Nova Scotia. Where *G. volans* and *P. leucopus* occur in Nova Scotia, they are sympatric with the generally more northern *G. sabrinus* and *P. maniculatus.*

We are grateful to Dr. D. G. Dodds of Acadia University, Dr. E. T. Hooper of the University of Michigan (UMMZ), Dr. R. L. Peterson of the Royal Ontario Museum (ROM), Mr. F. Scott of the Nova Scotia Museum (NSM), and Mr. P. M. Youngman of the National Museum of Natural Sciences, Ottawa (NMC) for cooperation and assistance in identifying and measuring specimens.

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A Second Sight Record of the Indigo Bunting for British Columbia

Godfrey (1966. The birds of Canada, National Museum of Canada Bulletin 203, p. 367) reports the status of the Indigo Bunting (*Passerina cyanea*) in British Columbia as "Hypothetical (sight records only)" on the basis of an adult male observed by the late Mr. Sam Sopkinson at Trail, B.C., during the summer of 1958. This is the first published record for this species from British Columbia.

On June 30, 1972, Laurie Street began observing a second adult male Indigo Bunting at South Slocan, B.C. and observations continued until at least July 26 when William Merilees located probably this same bird, at which time the following field notes were made: "Sparrow size, possibly smaller than a Lazuli Bunting; breast all blue, darker than either a Lazuli or Mountain Bluebird, possibly darker also than a Western Bluebird; bill, heavy, black; flight, undulating (up-hill); singing 12:00 noon to 1:00 p.m., the day hot, 80°F plus, moving from tree to tree; song, five notes, the first two identical, the third lower, ending with a *chee chee.*"

Since South Slocan is only 26 miles north northwest of Trail, B.C., perhaps the Indigo Bunting is a more frequent visitor to this area than these records suggest, particularly as the West Kootenay area is poorly known ornithologically.

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The Bluethroat, a New Bird for Canada

While working for LGL Limited (Environmental Research Associates) on the avifauna of the Yukon North Slope, we observed and photographed a singing male Bluethroat (*Luscinia svecica*) on 9 June, 1973. According to Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203), this species has not previously been recorded for Canada.

The Bluethroat was seen near a small unnamed tundra lake (68°56′ N, 138°30′ W) beside the Babbage River, Yukon Territory, 17 miles from the coast and approximately 15 miles from the British Mountains. A patch of shrubby willows (from 2 to 5 feet high), located at the end of a small creek between the lake shore and the foot of a gently rising hill, was the center of the bird's activities.

The bird was first observed by P. S. Taylor and R. E. Salter from 0745 to 0830 hours (Alaska Daylight Saving Time), and later by M. A. Gollop and M. J. Taylor, the last sighting being made by all four people at approximately 1230 hours. Binoculars and a telescope were used to view the bird, and recognizable [editor's note — but not printable] photographs were taken with 400-mm lenses. Later efforts to locate the Bluethroat failed.

Excellent light allowed us to see the plumage characteristics of this male Bluethroat very well. The top of the head, hind neck, back, and wings were a dull olive-brown color. A whitish superciliary line was bordered below by a dark eyeline. The vivid blue coloration of the throat extended around a small rusty red spot on the upper breast, below which was a blackish band and a rusty band. Its lower breast and belly were white. Two small black spots on the upper belly may have been plumage discoloration. The rusty red tail was tipped with a wide dark brown band, the dark brown extending up the central (two?) tail feathers.

Our attention was first attracted to the Bluethroat by its flight song. The male left its perch on a willow, ascended to about 30 feet where it began to sing, and then descended steeply with twisting flight and partly opened wings and tail to a new perch some yards away. Occasionally the bird perched low in the willows out of view, but usually it chose a prominent branch on which to land. If we approached closer than about 50 feet it flew away or dropped down into the willows. While perched it frequently fanned its tail; this behavior and the color pattern of the tail were similar to those of the American Redstart (*Setophaga ruticilla*).

The flight song included a great variety of loud, rather harsh notes, each repeated from 1 to 10 times (usually 3 to 5 times), one song usually being of fewer than three different notes. The notes included a redpoll-like *twee,* a frog-like *chirp* or *chup,* a metallic *cleep,* a *bzzew,* and a *rzz.* Other than the flight song, the bird was usually quiet. The Bluethroat made at least one flight song every 5 to 10 minutes for the duration of our observation.

Bluethroats breed regularly in Alaska. However it is interesting that Gabrielson and Lincoln (1959. Birds of Alaska. Wildlife Management Institute, Washington, D.C.) do not mention that this species has a flight song. If male Bluethroats with established territories do not regularly indulge in flight songs, it might explain why the male we saw was advertising so vigorously. His short but vigorous activity in the area suggests that he was searching for a mate, and then moved elsewhere. Still, we are open to the possibility of Bluethroats' nesting in northern Yukon, since our ornithological investigations in Alaska during July 1973 revealed a male and female Bluethroat feeding a recent fledging along Okpirourak Creek, only 65 miles from the Canadian border.

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The Eastern Chipmunk, *Tamias striatus,* in Insular Newfoundland

The eastern chipmunk is one of the most familiar small mammals of eastern mainland Canada but it is not native to insular Newfoundland. (Cameron, A. W. 1958. Mammals of the islands in the Gulf of St. Lawrence. National Museum of Canada Bulletin 154. 165 pp.; Peterson R. L. 1966. The mammals of eastern Canada. Oxford University Press, Toronto. 465 pp.). Realizing that this attractive and colorful small mammal would be esthetically valuable to the province's parks and wild areas (as well as possibly contribute to the meagre small-mammal prey base), the Newfoundland Wildlife Division introduced the species to the island in 1962. Thirty chipmunks were live-trapped in the Tobiatic Game Sanctuary, southwestern Nova Scotia, in August and released in Barachois Pond Provincial Park in western Newfoundland in September (Figure 1). Ten individuals were males, nine were females, sex of the remaining 11 was not determined.

In 1964 26 chipmunks from the same area of Nova Scotia were released in Squires Memorial Park in western Newfoundland (Figure 1). In August 1968, 19 individuals from the Barachois Park population were introduced to Butterpot Provincial Park in eastern Newfoundland (Figure 1).

The original introduction at Barachois has been successful. A good population presently exists in the park, and dispersal has occurred for 40 miles in a southerly direction, 20 miles in an easterly direction, and 10–15 miles in northerly and westerly directions (Figure 1).

The species is not distributed evenly throughout this 500-square-mile area around Barachois. What appears to be discrete populations are scattered through the area and are correlated with the presence of the hardwood stands that occur throughout this predominately conifer region. Chipmunks are most consistently observed where hazelnut (*Corylus cornuta*) is abundant, although white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*) are the most common hardwoods in the area. These hardwood stands provide the conditions of ground litter, blowdown, open areas, and food that make suitable chipmunk habtitat.

The 1964 introduction of 26 animals into Squires Memorial Park appears to have been unsuccessful. A few observations were made shortly after the introduction, but it is probable that none of the chipmunks survived the first winter since no animals were observed after that. The habitat in the park is more completely conifer, and lacks the many small hardwood stands and associated blowdowns and forest floor micro-habitat that are found in Barachois.

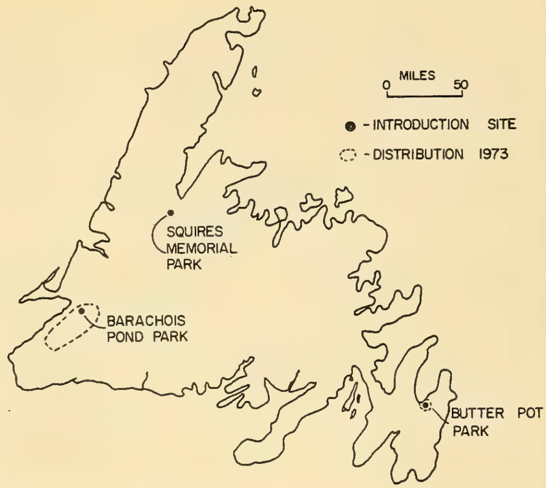

FIGURE 1. Map of Newfoundland showing sites of *Tamias* introduction and 1973 distribution.

The 19 individuals introduced into Butterpot Park in 1968 have given rise to a small population now resident in the park. Little if any dispersal has occurred from the park. Habitat inside Butterpot is suitable for chipmunks, and other suitable areas exist in eastern Newfoundland. Conifer forest and barrens occur in the vicinity of Butterpot, however, and natural dispersal of chipmunks across these areas to regions of suitable habitat is unlikely to occur rapidly, if at all.

Thus it would appear that while the west coast of the province has a slowly expanding *Tamias* distribution, the rest of the island is still without an established population. Discontinuous and small areas of suitable habitat occur across Newfoundland but, with the exception of the Barachois area, these are unlikely to be filled by natural dispersal.

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Sight Record of a Cougar in Northern Ontario

This note records the sighting of a cougar, *Felis concolor,* in Ontario in August 1973. The cougar was seen about mid-morning on August 13 near Highway 11, less than 10 miles west of Hearst, in the District of Cochrane.

My husband and I, with three teen-aged children, were having a lunch by the roadside near our parked vehicle, when our son Bill drew attention to a huge beige cat that came out of the bush onto the edge of a cleared field about 100 yards from where we were standing. The cat walked along through the tall grass and shrubs at the edge of the field, with one or two low bounds over shrubbery. It was in view, or partly in view, for a distance of about 30 feet.

The animal was an even, warm, beige color, smooth-furred, and with a long tail. There was a smooth, rounded, clean-cut appearance about the shoulders, neck, and head. My impression was that the animal stood about as high as a German Shepherd dog, but with the profile and gait of a lean house-cat. Twice it turned its head to look in our direction and, although the sun was behind us and shining on the cat, we saw no suggestion of ear tufts or lynx-like facial pattern.

It disappeared back into the bush with a low scrambling bound, and we walked across the cleared field to examine the ground where it had been. The woods behind the field were low-lying and swampy, with tangles of dead standing spruce in what appeared to be beaver-flooded bush. We found one fist-sized footprint in damp clay, imperfectly registered as the cat had skidded slightly, but it showed a cat-like track, with toe-prints fanned across in an arch in front of the central pad. Apart from this one print, we could make out the route the cat had taken through the damp grass, but nothing else.

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Editor's note: This account is similar to a number of other reports that have accumulated in Ontario over the past 25 years, yet in no case has there been any documentary proof of the occurrence of cougars in this province. In some cases evidence such as plaster casts of tracks, and even bits of hair have been submitted as evidence, yet in all cases so far the submitted evidence has proved to be other than that of cougar. The foregoing description of the animal observed, however, clearly suggests a cougar. Does such a record without substantial evidence warrant publication? Does the accumulation of such sightings constitute a contribution to knowledge? Present editorial policy is to publish sight records made by experienced and reliable observers. For further information on this policy see Sight records of birds by W. Earl Godfrey on page 107.

Broad-leaved Helleborine Now Present in Manitoulin District, Ontario

The weedy European orchid *Epipactis helleborine* (L.) Crantz was introduced into North America, probably accidentally, in the 19th century. It was first found near Syracuse, New York, in 1879. Since then it has spread with remarkable speed, and the range extension is continuing. Its distribution has been mapped by Soper and Garay (1954. The Helleborine and its recent spread in Ontario. Federation of Ontario Naturalists Bulletin 65. pp. 4–7) on the basis of information then available. In recent years the Ottawa Field-Naturalists' Club native orchid survey has provided a mass of new sight records, and the details of the distribution pattern are better defined.

Epipactis helleborine is very common in southern and eastern Ontario, where it usually occurs in mixed and evergreen woodland, often in profusion. Observations towards the northwestern limit of its range suggest that populations are much smaller there. The species is present in Muskoka,

and moderately frequent on the Bruce Peninsula. Ten years ago, however, it did not seem to be present in Manitoulin Island (Soper, personal communication).

During the latter half of September 1973, I spent a week in Manitoulin doing field work for the orchid survey. When the trip was discussed with Dr. J. H. Soper, Chief of the Botany Division, National Museum of Natural Sciences, Ottawa, he urged me to try hard to find the Broad-leaved Helleborine. He predicted that it should be there, basing his opinion on the known history of its range extension and the nearness of known sites on the mainland to the east and southeast. He was right.

Five stations for *E. helleborine* were found in the eastern half of Manitoulin Island. Two had reasonable numbers of plants (60, 32) allowing the taking of voucher specimens for the National Museum of Natural Sciences herbarium (CAN). The other sites were accidentals, with one plant each; these were left undisturbed.

The extensive examination of appropriate habitats, made during the week in Manitoulin, makes it certain that the comparative rarity of this species there is not an accident of observation. The plant was absent from very many quite suitable sites. On the other hand, all the capsules of even the single plants were maturing, and producing seeds abundantly. Propagation and local spread of the population will be quite rapid.

I conclude that there is a high probability that *E. helleborine* extended its range into Manitoulin Island within the last decade.

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Physcia lacinulata Müll. Arg.: A New Lichen for Canada

Physcia lacinulata was gathered on October 12, 1971, near Foresters Falls in Renfrew County, Ontario. It is the first known collection for Canada.

The specimen was identified by the tiny squamule-like 'ruffles' on the lobe margins, with the use of M. E. Hale's new key (Hale 1969), but a more complete description could not be found in other literature available to me. A specimen was forwarded to Dr. I. M. Brodo at the National Museums of Canada. He confirmed the identification and sent material to Dr. John W. Thomson, an authority on the genus, who wrote that the lichen appears to be "a rare eastern North American species."

In the field the thallus might be mistaken for a patch of *Cladonia* squamules. The thallus is 30–40 mm, sometimes more, in diameter, and is composed of tiny squamules less than 3 mm wide. The margins of the lobes bear abundant squamiform isidia. The upper surface of the lichen is mineral-gray when dry, grass-green when wet. The lower surface is white with simple rhizines that are black when mature, with the white tips typical of the genus.

The specimen grew with hepatics, loosely attached to a limestone boulder. This rock was isolated on a north-facing, wooded slope underlain with Precambrian granites. Soil is a calcareous till derived from Ordovician limestone (Gillespie et al. 1964). Rock outcrops of the limestone, in a white crystalline form similar to the boulder, are common in the area and some of the rock is known to contain both calcium and magnesium. Near the boulder there are young deciduous trees such as *Fraxinus americana* L.; the ground is well covered with grasses and sedges and the only know patch locally of *Allium tricoccum* L. Other parts of the steep slope bear more mature trees that include *Pinus strobus* L., *Tsuga canadensis* (L.) Carr., and *Betula alleghaniensis* Britt.

The general area is of interest botanically, for it marks the apparent limit in the Ottawa Valley of many lime-loving herbaceous species and of trees such as *Carya cordiformis* (Wang.) K. Koch, *Juglans cinerea* L., and *Ulmus thomasii* Sarg.

Physcia lacinulata is probably more common than its few North American localities would suggest (see below). From other similar lichen distributions one might surmise that the Ontario specimen is close to the northern limit of its range.

Specimen seen: Foresters Falls, Ontario. Renfrew County, 45°42′ N, 76°43′ W. Rich calcareous woodland. *M.I. Moore 5712,* 12 October, 1971 (PFES, CANL).

Known distribution: western North Carolina, northern Georgia, Wisconsin (Thomson 1963); Virginia, Iowa, Minnesota, and Costa Rica (Thomson, personal communication).

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A Record of the Orchid *Malaxis monophyllos* (L.) Sw. from Northeastern British Columbia

Malaxis monophyllos (L.) Sw., the white adder's mouth, is one of the smallest orchids in Canada and is probably more often overlooked than rare. This plant prefers wet, shady locations and is typically found growing among mosses or sedges in bogs and cool woods. The general distribution of this orchid as described by Case (1964) and Szczawinski (1959) is Newfoundland, Labrador, and Quebec, south to New England, New York, and Pennsylvania, westward through the Great Lakes region to Minnesota and Manitoba, and also Alaska and the Aleutians. According to Szczawinski (1959), *M. monophyllos* is also found in British Columbia, being very rare and limited to the coastal regions only. Hultén (1968, p. 330) shows the distribution of this species in Alaska and British Columbia, as being spotty and coastal.

On July 19, 1973, *Malaxis monophyllos* was collected, in bloom, in northeastern British Columbia at Liard Hotsprings at mile 493 on the Alaska Highway. (The specimen is preserved as number 1052 in the authors' collection.) This location is approximately 250 miles from the Pacific coast. Porsild and Crum (1961) have published an excellent description and floral account of the Liard Hotsprings area, yet at that time *M. monophyllos* was not collected there. A group of three plants was growing in wet moss bordering one of the large shallow pools fed by the hot springs, in the area described as *Larix laricina* fen by Porsild and Crum (1961). The British Columbia Provincial Museum also has a specimen collected at Liard Hotsphings by Dr. A. F. Szczawinski on July 21, 1961 (No. 36037), but this record has not previously been published.

The hot spring areas of the northern regions are of interest because species of the more temperate regions survive there and are often disjunct from their main ranges in the continent. Perhaps *M. monophyllos* occurs in the Liard Hotsprings area because of the warmer, more humid conditions throughout the year, somewhat similar to those of the coastal region which it inhabits in the other parts of British Columbia. The only other species of *Malaxis* known to occur at Liard Hotsprings is *M. paludosa* (L.) Sw. (Case 1964).

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Orchis rotundifolia: Addition to the List of Plants of the Bruce Peninsula

On 24 June 1973, during routine field work for the Ottawa Field-Naturalists' Club Native Orchid Survey, a stop was made at a rather unpromising wet mostly coniferous woods near Tobermory, Ontario, in the Bruce Peninsula. The mostly barren forest floor contained a mossy pocket a few square meters in area, the carpet including some *Sphagnum*, with several species of orchids. *Listera convallarioides, Listera cordata,* and *Cypripedium reginae* were not unexpected, though the first two are not at all common, but I was quite surprised to find among them three plants of *Orchis rotundifolia* Banks ex Pursh, one of them in flower.

The *Orchis* is not included in the recent listing of the plants of the Bruce (Shivas, M. S., M. D. Kirk, W. K. Kirkwood, and C. Rolfe. 1969. Check list of the plants of the Bruce Peninsula, Federation of Ontario Naturalists, Don Mills, Ontario. 62 pp.) and I have not found any other attribution of the species to this area. The Bruce is rich in orchids, but from my own observations it has little of the habitat suitable for *Orchis rotundifolia* near the southern limit of the species' distribution. Most large southern colonies are in rich *Sphagnum* fens.

A total visible population of three plants was too small to allow collecting. However, we showed the colony to Dr. Donald Gunn of Oakville, who made color transparencies of the plants for deposit as vouchers at the National Herbarium, Ottawa (CAN.).

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A New Distribution Record for the Spongilla-fly, *Sisyra fuscata* (Neuroptera, Sisyridae)

On 11 September 1972, larvae of spongilla-flies were collected 40 km west of Edmonton, Alberta in Danard Lake (53°34′ N 114°10′ W).

Specimens, with their host sponge, *Spongilla lacustris* (Linnaeus), were transported to a laboratory at the University of Alberta, Edmonton, where they were maintained at 20°C in an aquarium surrounded by soil and branches of shrubs. On the morning of 13 September 1972, some larvae had left the water and were crawling about on the soil and twigs. That evening the first cocoons had been spun. In succeeding days more larvae left the water and spun cocoons. First emergence was noted on 6 November 1972. Photoperiod was not regulated, the insects being subjected to varying conditions. For the most part however, the lights were on for 10–14 hours per day.

The adults were identified as *Sisyra fuscata* (Fabricius), on the basis of wing venation and genitalia, according to Parfin and Gurney (Parfin, S. I. and A. B. Gurney. 1956. The Spongilla-flies, with special reference to those of the Western Hemisphere (Sisyridae, Neuroptera). Proceedings of the United States National Museum 105: 421–529). Two of the 27 specimens corresponded to *Sisyra vicaria* (Walker) on the basis of wing venation (placement of the distal R2 fork), but genitalia had the structure described for *S. fuscata*. Since Parfin and Gurney state that anomalous wing venations occur, all specimens were considered to be *S. fuscata*.

This represents a distribution record for the species and, in fact, for the family. The closest previous records are from British Columbia and Minnesota (Parfin and Gurney 1956). Subsequently, Mr. H. Boerger (personal communication) has collected larval sisyrids (unidentified) from the Bigoray River, 113 km west of Edmonton, Alberta.

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Snow Geese Nesting on Melville Island, Northwest Territories

While engaged in a study of Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) in August 1972 and July and August 1973, we observed eight pairs of Snow Geese (*Chen caerulescens*) and their broods on Melville Island, N.W.T. Melville Island has not previously been reported as a nesting area for Snow Geese. We offer the following observations as evidence for Snow Geese nesting on Melville Island.

On 13 August 1972 two adults and five goslings were seen about 2 kilometers south of Shellabear Point on the north coast of the Dundas Peninsula (74°50′ N, 113°14′ W). The geese were on a small freshwater lake about 0.5 kilometers from the coast.

On 27 July 1973 four adults and seven goslings were seen 10 kilometers north of the southeast corner of Sabine Bay (75°34′ N, 108°50′ W). The geese were in a coastal saltwater cove about 10 meters from shore.

On 28 July 1973 six adults and eight goslings were seen about 10 kilometers west of Palmer Point on the southeast coast of Melville (74°56′ N, 108°12′ W). The geese were on a small lake about 1 kilometer from the sea-coast.

On 29 July 1973 two adults and five goslings were seen about 8 kilometers southwest of Shellabear Point on the north coast of the Dundas Peninsula (74°49′ N, 113°29′ W). The geese were on a saltwater lagoon about 0.5 kilometers from the coast (about 6 kilometers west-southwest of the 13 August 1972 sighting).

On 1 August 1973 two adults and three goslings were seen about 3 kilometers southeast of Cape Mudge on the west coast of the Sabine Peninsula (75°53′ N, 109°58′ W). The geese were swimming in the mouth of a saltwater bay.

During the two summers we saw a total of 16 breeders with 28 goslings. Only an additional 11 non-breeders were seen on Melville Island during the same period.

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Costa's Hummingbird, a New Bird for Canada

Abstract. A Costa's Hummingbird *Calypte costae* was present at Victoria, British Columbia, from April 14 to April 17, 1972. This is the first record of the species for Canada.

During the evening of April 14, 1972, the first-named writer observed and identified an adult male Costa's Hummingbird *Calypte costae* in his garden at Penrhyn Street, near Cadboro Bay, Victoria, British Columbia. The bird was feeding from hummingbird feeders and from the blooms of Red Flowering Currant *Ribes sanguineum*. The bird was watched by many of Victoria's birdwatchers the following two days, at ranges as close as 3 feet. Among the experienced birdwatchers who saw the bird and concurred with its identification were Mr. and Mrs. A. R. Davidson, R. Fryer, F. Lansdowne, R. Satterfield, Rev. and Mrs. D. B. Sparling, and D. Stirling. It was last seen on the morning of April 17.

Field notes were made, as well as a color painting by A. R. Davidson, based on these notes. The field notes and the painting are in the files of the Ornithological Records Committee for Southern Vancouver Island at the address of the second author. The record was accepted by the Committee at its meeting of April 1973 and is listed in the 1972 Annual Bird Report for Southern Vancouver Island (Tatum 1973).

A synopsis of the more important features of the field notes follows. Size close to that of a Rufous Hummingbird *Selasphorus rufus*. Back, wings and tail green, the wings darker than the back. Forehead and throat purple, changing from black to red-purple with occasional flashes of scarlet and green. The feathers of the gorget were long, and in some attitudes, when the bird was at rest on the currant bushes, extended beyond the nape. Breast and belly white, with some light gray on the flanks. A white line behind eyes to side of face. It appeared aggressive towards Rufous Hummingbirds.

Mr. V. Walton, vice-president of the Vancouver Island Cagebird Society, and Mr. J. van Oosten, director of Woodland Park Zoological Gardens, Seattle, have informed us that, to their knowledge, no one keeps this species in captivity in British Columbia or Washington, and it seems extremely unlikely that the Victoria bird was not a wild bird.

Costa's Hummingbird is a bird of the arid desert regions of southern California, Nevada, Utah, and Arizona. It is not highly migratory and it does not normally occur much further north than central California. With the intense activity of modern birdwatching, however, anything may be discovered anywhere; it is important not to

attempt too deep an interpretation of single birds that have strayed somewhat from their normal range.

The Victoria record was not quite isolated, however, for there is a record of a Costa's Hummingbird photographed in Oregon at very nearly the same time (April 16 to April 20, 1972) as the Victoria bird (Crowell and Nehls 1972). The photograph of the Oregon bird is on file at the Migratory Bird Populations Station at Laurel, Maryland. Monson (1972) also reports that in New Mexico Costa's Hummingbirds were straying much farther east than usual in March 1972.

The Victoria record is the first record of a Costa's Hummingbird in Canada.

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The Whistling Swan Nesting in Northern Baffin Island, Northwest Territories

Godfrey (1966) has described the distribution of Whistling Swans, *Olor columbianus* (Ord), in Canada. He reported no observations for the eastern Arctic north of a line joining Taverner Bay and the north shore of Cumberland Sound, Baffin Island. Sachs Harbour, Banks Island, marks the northern limit for the species in the western Arctic. Tuck and Lemieux (1959) did not observe swans on Bylot Island nor report them as ever having been seen there or in adjacent regions of Baffin Island.

On July 22 and 29, 1970, the senior author recorded a pair of swans in Navy Board Inlet near the mouth of the Mala River, Baffin Island (73°02′ N, 80°41′ W). Specific identification was not possible. In view of the restricted distribution of the Trumpeter Swan, *Olor buccinator* (Richardson) (Godfrey 1966), and the extensive range of the Whistling Swan, however, they were considered to be of the latter species.

On July 31 Heyland censused the Greater Snow Geese (*Anser caerulescens atlantica*) in the delta of the Mala River by means of vertical aerial photographs. Subsequent examination of the film revealed an isolated pair of white birds accompanied by two smaller and grayer birds. All four were considerably larger than were the Snow Geese on the same exposure. Because the relief of the terrain was flat the differences in size were not due to differences in scale on the exposure. Heyland (1972) has shown that gray Snow Goose goslings are readily distinguishable from white adult birds on vertical black-and-white aerial photographs. Because young swans are gray there is no doubt that they would also be easily distinguished from white adults. It was concluded, therefore, that the four birds constituted a two-cygnet family of swans. Because it was unlikely that two pairs of swans were to be found in the area this family must have been the one observed by Mary-Rousselière.

To our knowledge this is the first reported and published observation of Whistling Swans nesting in northern Baffin Island, and the most northerly for the Americas. The senior author has photographs of the birds in his photo collection.

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Sponges of Minas Basin, Nova Scotia

The general physiographic features of the unique Minas Basin were described by Bousfield and Leim (1960) in their major paper which summarized the faunal records for 10 phyla. Since that publication appeared, members of the Biology Department, Acadia University, have been collecting specimens of Minas Basin fauna and the result to date has been the addition of approximately 100 species to that list. Much of this material is as yet unpublished, however, partly because of the dearth of experienced systematists and the quantity of material with which ecologists and physiologists so casually inundate them.

The convenient proximity of Acadia University to Minas Basin makes feasible the pursuit of field studies all year round. Low-water communities can be sampled during the maximal extreme low-water spring tides which more often occur during the academic year than during the summer field season. These occasional extreme lows expose acres of sublittoral fringe and make possible the *in situ* collection and photography of many species usually obtained only from dredge samples (Bleakney 1972; Bleakney and McAllister 1973).

This preliminary account of sponges is based upon collections* and observations taken at extreme low-water springs in two areas: the southeast shoreline of Cape Blomidon (Figure 1) and one half mile east of Longspell Point at Kingsport (Figure 2). These two areas were chosen because they were the only sites along the western Basin shore (Figure 3) where sponges have consistently been observed over recent years. The Tide Table predictions for Saint John, New Brunswick were used for planning field excursions, and the tide levels on those nine

*Specimens can be keyed out by referring to Hartman 1958 and Hartman 1964.

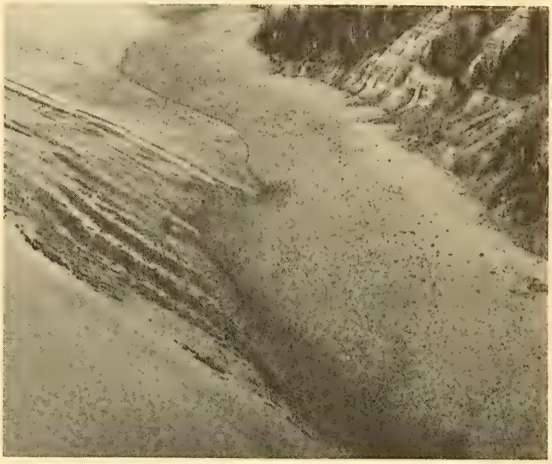

FIGURE 1. Air photo from 400 feet, taken on 27 April, 1971, during a +0.7′ tide, of the sandstone terraces at the southeast face of Cape Blomidon. Note trees on cliff face, talus slope of basalt rocks extending out over tilted sandstone strata which has eroded to form long narrow tide pools.

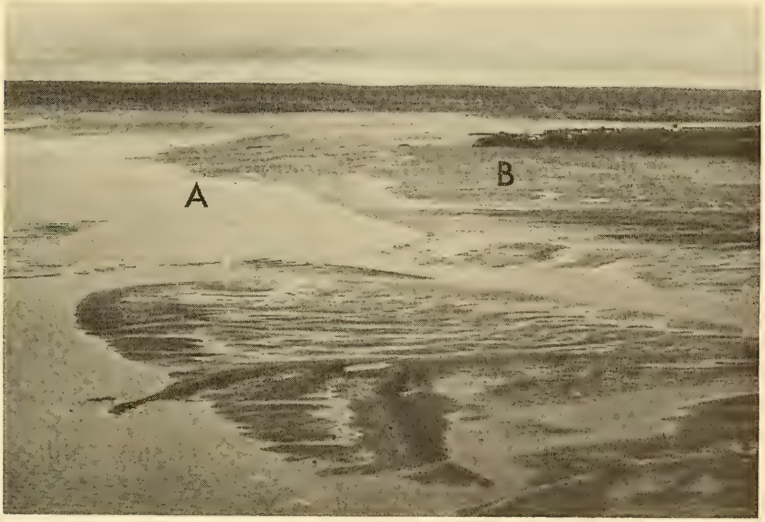

FIGURE 2. Air photo from 300 feet, taken on 27 April, 1971, looking southwest across the sandstone outcroppings (A) with Longspell Point and the town of Kingsport at upper right of picture (B). The interesting area in foreground has yet to be examined.

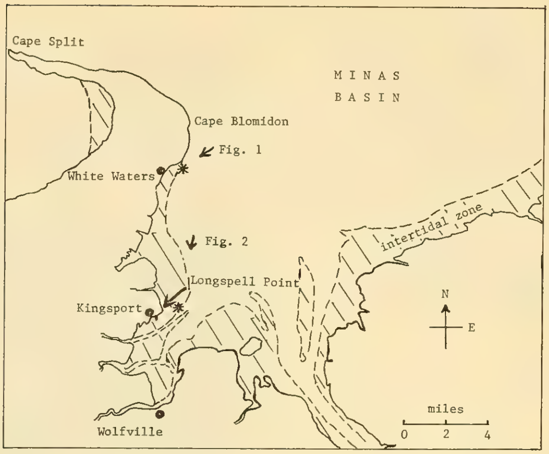

FIGURE 3. Map of southwestern shore of Minas Basin showing location of Acadia University at Wolfville and the two study areas. Arrows indicate view line of the two air photos.

trips varied from −0.6′ below to +1.0′ above 0 Datum. Both areas are of sandstone outcroppings over which are scattered basalt rocks, which provide an additional substrate for the attachment of sponges. Areas nearby, however, which appear similar, do not support the density or diversity of sponges that has been observed east of Longspell Point at Kingsport.

Bousfield and Leim (1960) did not include the Phylum Porifera in their faunal list, but on page 11 they referred to Whiteaves (1901), who reported two species collected in 1881, *Haliclona* (his *Chalina*) *oculata* and *Isodictya* (his *Desmacidon*) *palmata*. Kindle (1917) collected intertidally and carried out dredging operations, but reported only one species, *Isodictya palmata,* and that so abundant at the mouth of the Avon River and near Kingsport as completely to fill the dredge. We have not been able to identify this latter species from our limited collections, which did not include dredging. Five of the six species described below, however, *Halichondria panicea, H. bowerbanki, Microciona prolifera, Cliona celata,* and *Polymastia andrica* are additions to the known fauna of the Minas Basin, although none are new to Canadian waters.

The red sponge, *Microciona prolifera* (Ellis & Solander, 1786) grew profusely in the Kingsport study area, attached to the tops and sides of sandstone outcroppings in both the encrusting and branched form. In the Cape Blomidon area it grew only in the encrusting form on the vertical faces of the sandstone terraces. De Laubenfels (1949), though he cited Nova Scotia and the Carolinas as range limits, stated that the occurrence of this species both north and south of Woods Hole was rare. The warm waters of the Minas Basin do support a community of disjunct southern species, as first pointed out by Bousfield and Leim (1960), and this sponge species may well be another example. (Collected near Kingsport: 19 Jan. 1969 (1); 4 Oct. 1971 (3); 1 Nov. 1971 (3). Near Cape Blomidon: 7 Oct. 1971 (2).)

The boring sponge *Cliona celata* (Grant, 1826), finding little suitable calcareous substrate such as oysters or other thick-shelled molluscs in either study area, was predictably uncommon. Warburton's (1958) publication on *Cliona* in eastern Canada made no mention of *Cliona* in the Minas Basin. There are three growth stages of *Cliona celata*: the alpha-stage found in self-excavations in molluscs' shells, the beta-stage as a transitory one when the sponge begins to overgrow its excavations, and the gamma-stage which leaves no trace of the original calcareous substratum. All four specimens of *Cliona celata* collected off Longspell Point were in the gamma-stage on basalt rocks. These colonies formed large thick mats and their undetermined initial calcareous substrate had been entirely eliminated. The only dominant sessile mollusc on these rocks is the slipper limpet *Crepidula fornicata,* and these along with barnacles presumably form the original calcareous substrates in the Minas Basin. (Collected near Kingsport: 4 May 1969 (1); 3 July 1969 (1); 4 Oct. 1971 (1); 1 Nov. 1971 (1).)

Another species found sparingly near Kingsport was the papillate sponge *Polymastia andrica* De Laubenfels, 1949, which occurred exclusively on small pieces of basalt rock. Single specimens covered an area 6-8 cm^2 with a plushy base from which projected 10 to 26 conical fistules of 1.5-2.0 cm in length. Several specimens were observed in 1969 in sandy areas where the basal rock was buried, leaving only the fistules exposed. (Collected near Kingsport: 2 July 1969 (1); 5 Oct. 1971; 1 Nov. 1971 (1).)

The bread-crumb sponge, *Halichondria panicea* (Pal-

las, 1766) was common to both areas. Colonies were attached beneath, and on the sides and tops of, sandstone and basaltic rocks. Both varieties occurred in the two study areas but the flabellate olive-green form tended to predominate at Kingsport, while the encrusting form prevailed on the seaward side of the sandstone terraces at Cape Blomidon. One specimen from Kingsport (4 Oct. 1971) was tentatively assigned to the species *H. bowerbanki* (Burton, 1930). (Collected near Kingsport: 4 Oct. 1971 (1); 1 Nov. 1971 (3). Near Cape Blomidon: 7 Oct. 1971 (2).)

Specimens of the eyed finger-sponge, *Haliclona oculata* (Linnaeus, 1759), found at Kingsport, were attached to the gastropod *Crepidula fornicata,* to a waterlogged wooden pole, and to basalt rocks. Unfortunately this material was not well preserved and it may be that several of the specimens are actually the very similar *Isodictya palmata* (Lamark) Bowerbank, 1858, that was reported by Kindle (1917) as abundant. Thus, although we could not find any of the diagnostic microscleres in our material, we are reluctant to state that *I. palmata* is no longer common in the western Minas Basin. (Collected near Kingsport: 19 Jan. 1969 (1); 4 Oct. 1971 (3); 1 Nov. 1971 (3). Near Cape Blomidon: 7 Oct. 1971 (2).)

Thirty-five specimens were examined in the laboratory, 108 microscope slides prepared, and from this material six species were identified. Several specimens remain doubtful because they were not preserved properly or appeared intermediate between *Halichondria panicea* and *H. bowerbanki*. Dr. W. D. Hartman, in correspondence, confirmed our impression of the paucity of definitive monographs of western Atlantic Porifera. Gosner's recent (1971) guide to invertebrates of our Atlantic coast is an excellent book for the available taxonomic literature on all marine invertebrate groups. In the only recent treatise devoted entirely to Porifera (Fry 1970), it was pointed out that the dearth of ecological and zoogeographic papers at that symposium was a reflection of the unavailability of adequate keys based on analysis of extensive collections.

An important, perhaps unique, feature of the Minas Basin is that by utilizing the periods of predictable maximal extreme low-water spring tides, the ecology of invertebrate communities such as these five genera of essentially sublittoral sponges can be conveniently studied *in situ* on both a descriptive and an experimental basis.

The zoogeographical picture for marine invertebrates which is emerging for Nova Scotia is one of a complex fauna composed of European (amphi-Atlantic) species, arctic species, endemic Canadian (boreal) species, and species which range northwards into the area from communities farther south along the United States coast. As most keys have been generated in the United States, they are usually deficient in species in the first three categories. Therefore, if valid keys are to be produced for Canadian coastal areas, they will have to be based on careful comparative studies of material from south of Cape Cod, from the Atlantic provinces, from the subarctic, from southern Greenland and Iceland, and from various regions of western Europe.

Acknowledgment

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Great Horned Owl Feeding on a Road Kill

On 14 February 1973 at approximately 22:00 hours a car driven by Miss Carol Ziegler struck and killed a Great Horned Owl (*Bubo virginianus*) on a rural portion of Quebec Highway 39 about 3 miles north of Lawrenceville, Quebec. Just before impact the owl was observed feeding on the remains of a dead animal in the center of the road. Miss Ziegler stopped and recovered the owl. The animal upon which it had been feeding proved to be the partially decomposed remains of a domestic cat (*Felis catus*).

In my subsequent examination of the badly mutilated owl carcass I found it to be an adult male in apparently excellent condition, judging by the large fat deposits. Its stomach contents were exclusively cat remains and included the entire right leg, foot, and claws, in addition to various bits of fur, meat, and broken bones, the whole weighing 94 gm.

I believe the observation to be significant because it represents our first verification that Great Horned Owls utilize, at least to some extent, carrion as a food source. While utilization of road kills is frequently noted for a number of diurnal raptors, it has not been previously recorded for any species of owl.

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A Localized Mass Winter Kill of Cunners in Newfoundland

Green and Farwell (1971) reported that cunners (*Tautogolabrus adspersus*) in the laboratory are able to withstand temperatures below 0°C, and since cunners become torpid and remain in shallow water in winter, they must survive temperatures below this in the field. These authors also reported that they had never observed a mass winter mortality of cunners in Newfoundland, where this species is likely to be subjected to the lowest winter temperatures found throughout its range. There are reports in the literature of winter kills of cunners (e.g., Smith 1897; Sherwood and Edwards 1901; Bigelow and Schroeder 1953), but none of the reported incidents were directly observed and the circumstances of the kills were not fully known. This note describes a very localized winter kill of cunners which occurred in February 1973 at Upper Gullies, Conception Bay, Newfoundland and suggests its probable cause.

Dead cunners floated ashore in the immediate vicinity of the government wharf at Upper Gullies, where they were first observed by local residents on February 5. A representative of the Federal Department of the Environment visited the site on February 8 and he reported that many dead cunners were high on the beach adjacent to the wharf. Except for a few which evidently had been carried by birds or mammals, none were more than about 75 m from either side of the wharf (L. Cole, personal communication). On February 10 I visited the site of the kill and made the same observations as noted above. It was estimated that between 2,000–2,500 dead cunners were high on the beach and on the deck of the wharf. The only dead cunners not within about 75 m of the wharf were partially eaten. Many of the cunners were embedded in ice and all were frozen (air temperature was about −5°C). A random sample of 500 cunners was collected from the beach. These were later measured, and 50 were examined for food. They ranged in size from 120–430 mm (mean 177 mm) and none had any food in the digestive tract. The latter finding is in agreement with the report by Green and Farwell (1971) that cunners in Newfoundland do not feed during the winter.

On the day before dead cunners were first reported at Upper Gullies, a severe storm with strong northeasterly winds swept the Conception Bay area. The storm caused high surf conditions along the exposed parts of the southern shore of Conception Bay, including the Upper Gullies area. Residents of the area reported that at the time of the storm sea ice was all along the shore at Upper Gullies. The most likely explanation for the death of the cunners and for their limited distribution on the shore is that the storm surge carried ice crystals into the rock-filled base of the wharf resulting in the freezing of torpid, supercooled cunners. Subsequent diving observations indicated that the wharf is the only suitable place in shallow water at Upper Gullies where large numbers of cunners could find wintering sites.

To verify that torpid cunners could be killed by coming

in contact with sea ice, I released chopped sea ice into several crevices and holes, at a depth of 10 m, occupied by torpid cunners. On a dive the following day, dead cunners were found in crevices where ice had been released. No other dead cunners were observed and this was the only time dead cunners have been found in wintering sites. These observations were made at Broad Cove, Conception Bay at the site of the Lora I underwater habitat where I have made numerous observations of cunners throughout the year. The seawater temperature was −1°C, the same as that at Upper Gullies at the time of the kill.

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Alan Freeth Coventry

Photograph by J. R. MacDonald in the thirties.

A. F. COVENTRY, 1888–1973

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Alan Freeth Coventry died suddenly outside his home near Streetsville, Ontario on February 18th, 1973. On his death Canada lost a man who had become a legend in his lifetime, as a teacher and a leader in the fields of natural history and the conservation of natural resources. "Covers," as he was known to many of his students and all of his many friends and associates, was born in London, England, on September 23rd, 1888. He went to day school in the county of Surrey and later to Willaston, a Public School in Cheshire, in the north of England. ("Public Schools" are actually the private secondary schools of England.) Long before he went to Willaston, however, his interest in natural history had been awakened. "From our earliest days," wrote Coventry's sister, "we children were encouraged to take an interest in the world around us, and particularly in nature. Our father was a keen naturalist, and we used to go for long walks with him, which were always made interesting by the many things he was able to tell us and show us on our way." Covers as a boy started one of several collections of wild flowers he made during his lifetime.

At Willaston, Coventry had the good fortune to come under the influence of a Swiss science master, A. D. Tobler, a very fine teacher and enthusiastic naturalist. This contact must have given him a great stimulus and no doubt helped him to gain an exhibition (equivalent to a scholarship) to Magdalen College at Oxford University. He became a Demonstrator in Zoology during his undergraduate years and took his degree in Natural Science in 1910. A slim but powerful man, he somehow found time to become stroke of his College eight in rowing, with conspicuous success.

Shortly after graduation he worked with the staff of the Zoological Society's gardens at the London Zoo. But he got his real start as a professional zoologist by accepting a new post, curator of a new museum established at Rothesay on the Isle of Bute, off the coast of Scotland. There was already a flourishing natural history society there. He proceeded to organize the collecting and naming of the many marine invertebrates and fish, and to work on the exhibits. He acquired a rowboat and greatly increased the collections. He also began a herbarium of the local flora. It is interesting to note that his assistant for a time at the museum was a fifteen-year-old girl, Sheila M. Marshall, now a world authority on marine copepods.

Seeking to advance himself, Alan Coventry returned to England and after a brief interval of teaching he made the last move in his professional lifetime, to the University of Toronto, where he was appointed Lecturer in Vertebrate Embryology in 1912. During the First World War he was active as a Signals and Intelligence Officer, and also served in Europe in the Canadian Tank Battalion. He then continued to lecture in Toronto, and by 1941 he had become a full Professor. When he retired as Professor Emeritus in 1956, the university lost one of the few "characters" from its campus. Coventry was extremely rugged and virtually oblivious to heat and cold. He wore leather shorts (bought in Czechoslovakia) whenever he was on field trips, in all weathers, summer and winter alike, including subzero temperatures. In his classrooms he habitually affected the same ruggedness and deshabille which not only amused but also endeared.

A bachelor, Coventry lived in a suite of rooms at the top of Hart House (the University

intellectual, social, and athletic center for males). To these rooms he invited many undergraduate and graduate members for a "dish of tea" and conversation late into the evening. Perhaps this was what kept Coventry so young at heart for so long, but it was a two-way street. No one left without new ideas, and often new plans as well.

Natural History Interests

Most naturalists have a special interest in some form or group of animal or plant life. Coventry was not of this breed. To him the whole world of nature was of absorbing interest. He could be equally delighted by the antics of the large dock spider *Dolomedes,* the beauty of a calypso orchid, or the arrival of some early migrant shorebird. While his interests were extremely catholic he did know a few areas particularly well. Within fifty miles of Toronto he seemed to know every ravine, beach, back road, woodland, and pasture. He went frequently to Frank's Bay, Lake Nipissing, when the Ontario Fisheries Research Laboratory was located there. He was welcomed not only for his remarkable background of knowledge on almost any subject, and his ready wit, but also for a characteristic less common, in that he was a very sympathetic listener. By 1931 he had acquired four acres on Lake Timagami, in northern Ontario. This was Lynx Island, in one of the remoter parts of the lake. There, all alone, with great ingenuity, he built a summer cottage. His island was close to the little-known Forma Rosea Bay, so named because at that time it was the only known station in Ontario for *Castalia odorata* forma *rosea,* as it was then called. It is, of course, the pink form of the scented water lily, now *Nymphaea.* Coventry knew the little bay well but told its secret to few.

When at Lynx Island Coventry continued a project already begun elsewhere, the assessment of populations of small mammals, particularly *Peromyscus, Blarina,* and *Sorex.* He had started with *Microtus* populations around Toronto. It is now known from much more recent research that his estimates of populations were much too high, but he was working at a time when little attention had been paid to small mammal numbers.

Lake Timagami is a maze of winding bays; it contains more than twelve hundred islands and has, of course, much spectacular scenery. Here Coventry had full scope for one of his favorite hobbies, photography. He was a superb photographer and carried excellent equipment in the days before it was commonplace to do so. It is not surprising that for more than twenty years he was chairman of the Hart House Camera Club, and was responsible for the installation of much of the sophisticated developing and enlarging equipment there.

In 1934 Coventry was the leader of a group of sixteen naturalists who built a large but well-hidden cabin in a little-known forested gorge under a cliff in the Niagara escarpment, west of Milton, Ontario. A small spring of excellent water seeped out of the limestone talus a few feet from the cabin, which had sleeping accommodation for seven. Over a period of twenty years Coventry spent hundreds of weekends alone or with other members there. Phenological records of first flowering of plants, and bird and mammal observations were on charts on the walls of the cabin. There was a long bench for dissection of specimens, and the syndicate had its own plant collection. No path was made to the cabin, and it remained undetected and without vandalism for twenty-five years. The area had a surprising variety of habitats. The great shaded rocks of the talus slopes were covered with mosses of many species and with many ferns, including *Asplenium trichomanes* (maidenhair spleenwort) and *Camptosorus rhizophyllus* (walking fern). Hawks and vultures soared in the up-currents near the edge of the cliff-tops. Farther down in the valley a small trout stream meandered through an alder swamp. A short climb took one to a unique seven-acre pothole lake in the limestone, more than 70 feet deep and having at the proper time, in the leafy shallows near the surface, great numbers of newts in their prenuptial exercises. Coventry the scientist was fascinated by such phenomena; but as a natur-

"Covers" at the Federation of Ontario Naturalists' Summer Nature School at Camp Billie Bear, Muskoka District, Ontario, 1946. Photograph by Barbara E. Jaquith.

alist he seemed even more moved by the ethereal flute-like song of the Hermit Thrushes in the hardwoods surrounding the cabin.

He was an ardent member of the Brodie Club, a group of dedicated field-naturalists who meet regularly in the Royal Ontario Museum in Toronto. Coventry was also an active member of the Toronto Field-naturalists' Club. By 1931 there were twelve nature clubs in Ontario, but there was no particular contact between them. At a meeting of the Brodie Club, Coventry and two of his lifelong friends, J. R.

Dymond and T. F. McIlwraith, were asked to find means to carry out a union of all these clubs. Their report was adopted, and after some correspondence the Federation of Ontario Naturalists came into being, with Coventry as Secretary-Treasurer. In 1935 he presented the first brief on behalf of the Federation to the Ontario Legislative Committee on Game and Fish. The Federation grew and prospered continuously until it has now become one of the most influential organizations of its kind in Canada, and has had considerable effect on government policies. Coventry remained on the executive for many years, and at the time of his death was Honorary President. He received the F.O.N. Conservation Award in 1971.

The Federation of Ontario Naturalists has long sponsored summer camps for nature study,

"Covers" in a Calopogon bog at the Federation of Ontario Naturalists' Summer Nature School at Camp Billie Bear, Muskoka District, Ontario, July 12, 1963. Photograph by Martin Edwards.

first at Franklin Island, Georgian Bay, later near Huntsville, and now at Red Bay in the Bruce Peninsula, on Lake Huron. Coventry organized and ran the camp during several summers, and for many years was one of the leaders on the daily hikes. While other leaders were specialists in ornithology, botany, and entomology, Coventry concentrated on the whole animate and inanimate system. He tried to make his group understand the complex relationships between soil, water, and every form of life. His message never failed to infect the other campers. The mind and feelings that left this message are best described in a letter from Alice Ironside, a former graduate student, as follows, "A sense of wonder, an appreciation of beauty, keen powers of observation and an insatiable curiosity may well have been responsible for much of his enjoyment of life, his contribution to it and the success he achieved."

Mrs. Mary Devitt supplied a good example of his wit, which was a feature of the summer camps. "At the lunch table someone mentioned that no snakes had been reported at the camp. I had been wandering around myself that morning and had seen a striped one and I stated this. Covers asked me to describe it in detail, stripes and all. By this time every one at the table was listening. He then asked 'Mary, are you sure that it wasn't a chipmunk travelling fast?'"

His retirement from academic life in 1956 brought him even closer to nature. He settled into a small frame house on an unhurried sideroad in farming country, and made a garden of old-fashioned English flowers. After joining the South Peel Naturalists' Club he proceeded to make a comprehensive collection of the flowering plants of Peel County. He sent a note to England about this phase of his life, as follows, "Putting into order the specimens I collect during the summer is a time-consuming business, but enjoyable; each specimen as it is mounted and labelled recalls some pleasant day in the open and some interesting place, sometimes new, sometimes often visited, for to a naturalist no place is ever quite the same as it was on other occasions."

Coventry left his collections of plants to Erindale College of the University of Toronto. He continued his interest in photography and gave occasional illustrated lectures at the college and to other groups. His vast collection of black-and-white photographs and color slides have also found their way to Erindale College. Many of them have historical significance, besides being works of art. For his great contribution to the study of natural history he was elected an Honorary Member of *The Ottawa Field-Naturalists' Club* in 1971.

Conservation Interests

Coventry's greatest and most far-reaching success was in the field of conservation. In the depression of the early thirties, as droughts, floods, and erosion became more devastating south of the border he linked them together, much as Hugh Hammond Bennet was doing as Chief of the U.S. Soil Conservation Service. Bennet was probably the world's greatest conservationist and Coventry avidly read his superb articles and books and may well have met him. By 1935 Coventry was convinced that the same situation was occurring in much of southern Ontario and that something should be done about it. He felt that many ground water levels had become lower. (He did not know that the Dominion Government's staff had come to the same conclusion from well surveys over several counties.) He visited many of the eroded areas in Ontario, some of them with Charles Elton of Oxford, and this writer. He knew that some pilot project was needed. He proceeded to locate a small area for detailed survey, to find a sponsor for the work, and, with two of his colleagues in the University, to staff the project and organize it, with full cooperation from the local municipal council. The result, *A Report on the Natural Resources of King Township,* made headlines in the Toronto papers. Under the auspices of the Royal Canadian Institute, Coventry then gave a brilliant lecture on the report. Recommendations for new methods of cultivation, such as contour plowing and much reforestation were included in the report. Unfortunately both Dominion and Provincial Governments were loath to begin costly conservation work.

"Covers" at the Federation of Ontario Naturalists' Summer Nature School at Camp Billie Bear, Muskoka District, Ontario, 1945. Photographer unknown. Photograph supplied by Barbara E. Jaquith.

Coventry did not despair. He quietly continued to lecture, talk, and write about floods and erosion. He calculated the amount of silt going down typical rivers in floods. He was given much support by Watson Porter, Editor of *The Farmers Advocate.* Soon he had influenced so many people that, with others, he was able to organize a large conference of Federal and Provincial leaders known as the Guelph Conference. The two governments were by now so aroused by public opinion that they allotted funds for a larger-scale survey of the watershed of the Ganaraska River. The report on this survey forced the hand of the Ontario Government, which therefore now included a Conservation Branch in the new Department of Planning and Development, and passed the Conservation Authorities Act of 1946. This Act allows groups of municipalities to control

floods, publicize and control erosion, recommend improved farming practices, carry out reforestation, and improve conditions generally for wildlife and public outdoor recreation. The work is funded by municipal levies, greatly assisted by provincial, and in some cases federal, grants.

There are now 38 conservation authorities in Ontario, including within their boundaries about 32,000 square miles. Southern Ontario is almost blanketed with them and there are three or four in northern Ontario. All of this diverse activity, with its startling results, and field and office staffs in every authority, stems chiefly from the intense and dedicated work of one man, Alan Coventry.

He of course followed the activities of the authorities with great interest. After his retirement he lived in the Credit River watershed and he was appointed to the Parks and Recreation Board of the Credit Valley Conservation Authority. He had already recommended successfully the acquisition of the Cold Creek Swamp, a tiny and fragile community of more northern acid-tolerant plants growing in sphagnum, such as the smaller species of *Vaccinium*. This swamp was also found to contain a rare species of moss new to Canada. A board-walk was built to keep visitors from spoiling the area, which lies about twenty-five miles northwest of Toronto. Later he spurred the acquisition of another similar community of northern plants southwest of Orangeville.

The Conservation Council of Ontario is an organization that is greatly indebted to Coventry. It came about in this fashion. When the Canadian National Sportsmen's Show in Toronto began to have large profits its sponsors (a group from the Toronto Anglers and Hunters, headed by Frank Kortright) decided to put its profits into conservation. The best advice received came from three professors — Coventry, J. R. Dymond and T. F. McIlwraith. They recommended using some of the profits to set up the Council, an organization with a small permanent staff and an unpaid group of invited specialists in the various fields of conservation. The Council holds many meetings, both open and closed to the public, publishes unbiased reports on conservation, and advises the provincial government. Other profits have been passed out in grants for fish and wildlife research. This is just another example of the manner in which Coventry and his friends made their knowledge and influence felt.

Education and Scientific Interests

Coventry was an extraordinarily gifted and enthusiastic teacher. Perhaps he is best remembered for the exciting introductory classes in zoology to students in Honour Science and Forestry. Countless undergraduates listened with something like amazement to his brilliantly organized lectures, expressed in concise and faultless English, and accompanied by first-class drawings. He never resorted to witticisms but always received rapt attention. He had one unique skill. With consummate ease and a piece of chalk in each hand he could draw on the blackboard either a perfect circle or any convolutions of a bilaterally symmetrical animal. Using his wide knowledge of literature and history, he gave an inspiring course on the History of Biology during his later years at the university. He was a competent vertebrate embryologist and his lectures to senior students were also flawless expositions. Indeed he introduced some modern teaching methods to his embryology course; for example, he made and used excellent models that illustrated various stages of the development of embryos he studied. Many of these were from small mammals he trapped at Timagami.

Caught up and immersed in the world of teaching, and without an ounce of vanity in his make-up, Coventry never bothered to take a Ph.D. degree himself. He of course supervised the studies of many graduate students, and while some of the studies concerned vertebrate embryology, others included the ecology of birds, mammals and fishes. Coventry's horizon was constantly expanding and he was certainly one of Canada's pioneer students in ecology. Meanwhile the door of his office was always open, and he was a source of inspiration to all

who came to visit him. As mentioned earlier these visits extended far beyond the laboratories.

Although he did not publish many scientific papers, he was always interested in expanding what was known of natural history. In particular, he liked to discover extensions of the known ranges of plants. For example, he was the first to note the presence of *Phyllitis scolopendrium* var. *americana* (Hart's-tongue fern) in the Credit watershed, a considerable extension of its known range. He may not have reported this officially, as he was always afraid that such action might result in the wiping out of a small station of plants.

This writer is not competent to assess Coventry's research output, which was not great in quantity but is reported to have been of high quality. Of this, Dennis Chitty, a former student, now a professor at the University of British Columbia, wrote in a tribute: "Covers was not endowed with that fanatical form of tunnel vision which makes a person think some tiny abstract problem is of more importance than all the rest of human experience . . . In those far-off benighted days no one worried too much about a professor's research output. He was there to educate the young; if, in the course of so doing he played around with problems himself, so much the better for the education of the young."

His Legacy

Coventry left a double legacy, a generation of enlightened men and women, and a great improvement in the face of Ontario, setting a prime example for the rest of Canada. He never sought fame or fortune. His need was a small one, perfectly expressed in Thomas Hardy's "Afterwards".

> When the Present has latched its postern
> behind my tremulous stay,
> And the May month flaps its glad green
> leaves like wings,
> Delicate-filmed as new-spun silk, will the
> neighbours say
> "He was a man who used to notice such
> things"?

* * * * *

A small memorial to Coventry, an annual prize "The Alan Coventry Memorial Prize in Conservation and Wildlife Protection" will be established at Erindale College. The college will receive contributions, issue receipts for income tax purposes, and will administer the fund and prize. Checks should be made payable to Erindale College and sent to the college at 3359 Mississauga Road, Clarkson, Ontario; they should be designated for the Alan Coventry Memorial Prize and for the attention of Dr. J. Tuzo Wilson, President. This prize will be a small but continuing memorial to a man who made great contributions to Canada and to generations of students and close friends.

Letters

Yellow-billed Loon in Alberta

Editor:

Although I was happy to be informed of Mrs. Griffiths' Alberta report of a Yellow-billed Loon, (1973. Canadian Field-Naturalist 87: 182–3), I would like to correct the impression that I 'accepted' the identification as she suggests. Although I am aware of the qualifications of the observers, I have not examined field notes, am aware of the difficulties of certain identification even of Museum specimens of loons, and was unable to personally verify the observation in the field. I would not therefore feel justified in making any pronouncement (pro or con) on this observation.

As editor of the Alberta Naturalist I did publish Mrs. Griffiths' note (2 (3) : 39), with a brief comment which included a reference to the inclusion of the Yellow-billed Loon in Salt & Wilk's hypothetical list in 'The Birds of Alberta' (Government of Alberta, 2nd edition 1966, p. 501). Recent correspondence with Mr. Wilk verifies that the species was included on the basis of 'reported sightings from Lake Athabaska,' but that no more detailed information about these reports survives in his files.

In the absence of a verifiable specimen or photograph, the only way to deal satisfactorily with sight records is to have all the evidence examined by an independent committee of competent ornithologists, as is done in the United Kingdom, and some areas of this continent. The Federation of Alberta Naturalists has recently stimulated the formation of an Alberta Ornithological Records Committee under the chairmanship of Professor Salt, and I hope the Committee will have an early opportunity to give its opinion on the validity of the record.

David A. E. Spalding

Head Curator of Natural History
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The policy of The Canadian Field-Naturalist concerning the publication of sight records of birds is set forth by Dr. W. Earl Godfrey, Associate Editor (Ornithology) in the following statement. The same policy applies equally to sight records of all animals.

Editor

Sight Records of Birds

Occasionally readers ask why we publish sight records of birds that are not supported by either a specimen or a photograph. Although we do reject many such manuscripts, *The Canadian Field-Naturalist* has long had a policy of publishing some sight records of birds observed outside their known ranges, provided that the species concerned are reasonably easy to identify in the field and that diagnostic species characters were clearly detected by experienced observers. Perhaps this policy is particularly useful in a country such as Canada, where vast northern expanses are thinly settled and where, for some areas, records of birds must be sight records or nothing.

In publishing such sight records *The Canadian Field-Naturalist* implies, of course, no official acceptance of them. The fact that they are published does not make their data one iota more valid than if they were unpublished. They are sight records, nothing more. The facts, as related by the observer, are placed on record for any interested reader to appraise. No none is urged to use them against his better judgment.

Today, with the ready availability of excellent field guides to identification and of extremely efficient optical equipment, competence among bird observers is high. Records of occurrences that appear to be unusual tend to alert others who look for supporting occurrences. Thus, resulting additional records (sight or otherwise) may add up into useful patterns, or the original record may remain completely isolated, in which case it retains its hypothetical status at best and is to be treated with caution or even suspicion.

While in many cases it is quite true that either a specimen or an identifiable photo is necessary for the complete acceptance of a record, there are many cases where such evidence is neither possible nor necessary. We cannot afford to disregard completely the records of the reliable observers who are neither specimen collectors nor photographers, but just good competent birders. Such sight records, containing diagnostic aspects of species identifiable in the field, have a high content of accuracy and a very considerable usefulness when handled with caution and common sense.

W. Earl Godfrey
Associate Editor (Ornithology)

Climate, Man and History

By Robert Claiborne
Reviewed by D. R. F. Taylor in The Canadian Field-Naturalist 86(2): 191–192, 1972.

Editor:

Whether an author has a right to complain when a reviewer criticizes what he wrote is arguable; what seems to me unarguable is his right to object — strenuously — when the reviewer attacks him for statements he never made. This is the case with Prof. D. R. F. Taylor's review of my book *Climate, Man and History*.

At the very beginning of his review I am credited with the statement that my "principal objective in writing this book was to make money." What I actually said (p. 11) was that "my *original* intention . . . was . . . to make some money *in an honest and interesting way* (emphasis added). I trust I am not being captious in suggesting that making money in an honest and interesting way is one important reason why Prof. Taylor teaches geography — and is hardly a culpable fault in either of us.

Later, Taylor has me saying, apparently quite dogmatically, that "American climates . . . have a clear relationship . . . with [the U.S.] addiction to an empirical, pragmatic, cut-and-dry view of life." What I actually said (p. 383) was that this relationship existed *in my opinion*. That the U.S. national character has a strong pragmatic component is hardly a matter even of my opinion; it has been noted by commentators since De Toqueville. That this pragmatic bent is related to American climates — specifically, to the fact that European settlers of this continent were from the beginning, and repeatedly thereafter, confronted with climatic conditions that were both unfamiliar and demanding is obviously an hypothesis, but I think, a reasonable one.

If Taylor is — to say the least — careless in reporting my views, he is frivolous in the factual statements he chooses to criticize. For example, he describes as oversimplified and/or inaccurate my statement that the earliest stages of human evolution took place "in the rich forests of an Equatorial climate or something close to it." The reference was, of course, to the phase of primate evolution extending from the Paleocene to the Oligocene; that it occurred in dense tropical forest "or something like it" is a truism of primatology. If Taylor believes that the primates evolved in some other type of environment, he is not arguing with me but with the overwhelming preponderance of opinion among primatologists and paleontologists.

Taylor then misquotes me as stating that it was in an Equatorial climate that "some apes mutated into the first crude version of man." What I actually said (p. 79) was that this occurred "in the hot, tree-dotted grasslands of a savanna climate." I should have thought that the African excavations of Howell, Dart, the Leakeys *et al.* had put this statement beyond cavil; if Taylor has an alternative view, I cannot imagine on what facts it could be based.

Taylor finds "simplistic" my statement that man's achievement of civilization occurred in two stages, and was influenced by special climatic and geographic conditions at each stage. The two stages in question are, of course, those sometimes called the Neolithic Revolution and the Urban Revolution; their reality as key stages in human social evolution does not rest on my opinion but on that of virtually all archeologists and prehistorians. That geographic-climatic factors played a role is, again, not my unique notion but that of (for example) such qualified prehistorians as Keith Flannery and Michael D. Coe (see my bibliography).

In the preface to my book, I assured my readers that "none of the facts, however seemingly far-fetched, have been made up — at least not by me. For every factual statement, there is at least one, usually more than one, 'reputable' scientific source. Where the facts are controversial, as they often are, I have tried to so indicate . . ." I stand by every word of that. If Taylor chooses to disagree with my interpretations of the facts, that is his privilege. But when, without citing any evidence, he accusees me of writing "fiction," — while himself misrepresenting my views — he is engaging in irresponsible and, in my view, unprofessional conduct.

In simple fairness, I think your readers should be aware that, whatever the validity of Taylor's opinions, they are not shared by all experts in the field. Prof. Rhodes Fairbridge of Columbia has expressed himself as "enormously impressed by Claiborne's skill in presenting an extremely complex mass of often controversial data, in an understandable — more than that, in an exciting and

stimulating way . . ." Prof. H. E. Wright of the University of Minnesota recommended the book in The American Scientist (59, p. 775-6) "as a means of diversification to the scientist and historian and as stimulating to the layman without undue fear of its planting misstatements and false notions. Such books, especially if highly readable, are uncommon, this one qualifies." And *Science Books* (published by the American Association for the Advancement of Science) described it as "an excellent bridge" for "students studying history and earth science . . . also recommended reading for those teaching these subjects . . . A unique effort."

ROBERT CLAIBORNE

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Editor:

Writing book reviews is apparently a dangerous occupation. Such reviews are by nature brief statements of personal opinion rather than carefully documented statements. I was not over-impressed by Mr. Claiborne's book and gave my opinions as to why. Mr. Claiborne, and several other reviewers, do not agree. All this says is that their opinions are different from mine which I find perfectly acceptable.

I should like, however, to reply to the points in Mr. Claiborne's letter. First I expressed no criticism of Mr. Claiborne's desire to make money in an honest and interesting way; in fact I wished him luck. I agree that this is not a culpable fault and I never suggested it was.

Climatic determinism is an extremely controversial subject on which there is a considerable body of literature, much of it emanating from geographers. From the references cited in Mr. Claiborne's book he does not seem to be aware of much of this literature including such basic works as those of Elsworth Huntingdon. It is also worth noting that although environmental determinism is still argued for strongly by some of the authors of the neo-determinist school it has been largely rejected, especially in its extreme form, by a large body of scholars. The full quotation on the impact of American climate (on page 383) about which Mr. Caliborne complains is: "But if the American climates do not serve to explain violence in America, they certainly have a clear relationship — to my mind, at least — with an equally characteristic American trait: our addiction to an empirical, pragmatic, cut-and-dry view of life."

It would be foolish to suggest that climate has no influence on man; it is equally foolish in my opinion to postulate a direct cause and effect relationship given the evidence available.

Claiborne claims that I was careless in reporting his views when I gave examples of what I considered oversimplified and inaccurate statements. He was right in that I did not clearly specify which I considered inaccurate and which oversimplified. I shall take the statements I used and so do now:

1. "The prologue to . . . evolution occurred before the Glacial Epoch began, in the rich forests of an Equatorial climate or something close to it."

I consider this an oversimplified statement.

2. "There, some apes mutated into the first crude version of man."

Claiborne is right that he stated this occurred in the savanna climate and I do not question this. I still find this a grossly oversimplified statement.

3. "We can at any rate say with some certainty that the Glacial Epoch *accelerated* man's evolution."

I believe this to be an inaccurate statement. It can be postulated as a hypothesis but it is not a fact.

4. "The first thing to be said about geological revolutions as a possible cause of glaciation is that their pattern is right."

I believe this to be an inaccurate statement. There is factual evidence for a correlation between geological revolutions and *some*, but by no means all, glaciations.

I would be happy to debate with Mr. Claiborne or anyone else the validity of my opinions on these four statements.

I still find simplistic Claiborne's arguments that man's evolution took place in three stages. I also find simplistic the implication that special climatic and geographical conditions were major causes of what he calls the Neolithic and Urban revolution. I do not deny that environmental factors had an influence: I am simply of the opinion that the factors involved were much more complex and that an environmental determinism hypothesis, regardless of who supports it, is a simplistic one.

I found the book a mixture of fact, which is certainly there; opinion, which is again present; and fiction which to me is the presentation as a fact of something which has not yet been definitely established. These views are of course my own and I am sorry that Mr. Claiborne finds them unpalatable. There is no doubt that an enormous amount of effort went into writing the book; there is also no doubt that some readers will enjoy it. I have always believed that people should read the book rather than the book review.

D. R. F. Taylor

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Editor:

My only further comment is as follows:

I am happy to learn that Taylor's original statement, that my "principal objective in writing this book was to make money," was not intended to be offensive. It was, however, inaccurate.

On the statements which Taylor finds "oversimplified," this is perhaps a matter of opinion. What is not a matter of opinion is that both statements were taken from a chapter introducing a major section of the book, and *summarizing* points discussed in much greater detail later. Summary statements of this sort are, inevitably, often oversimplified.

On the relation between geological revolutions and glaciation, I believe my statement could more accurately be described as "controversial," in the sense that not all geologists agree with it. I so indicated in a footnote.

Finally, on the matter of "climatic determinism," I certainly agree that there is no "direct cause and effect relationship" between climate and human history, and regret that Taylor received a contrary impression. Throughout the book I sought to discuss the "influence" of climate as one of a number of factors. Admittedly, I said much more about climate than about concomitant influences — but climate, after all, is what the book was about. My failure to cite Huntingdon reflected not ignorance of his works but rather my feeling that he too often postulates precisely the sort of direct cause and effect relationships which both Taylor and I find unconvincing.

Since Taylor and I evidently agree that climate has *influenced* the course of the human drama, there remains only the question of whether the particular examples of that influence cited in my book are reasonable or foolish — and on that the reader must make up his own mind.

Robert Claiborne

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News and Comment

Editor's Report for 1973

The total number of manuscripts submitted for possible publication in *The Canadian Field-Naturalist* during 1973 was 153 (51 articles and 102 notes). The following table shows that this far surpasses the numbers submitted

Year	Number of Manuscripts	
	Received	Accepted
1968	83	73
1969	113	100
1970	85	66
1971	86	67
1972	119	86*
1973	153	—

*Disposition of 11 other manuscripts has not been finalized.

in previous years. Although approximately 80% of submitted manuscripts are eventually accepted for publication, most manuscripts require revisions (sometimes extensive revisions) beforehand. Some manuscripts, after careful consideration by referees and the Editor, are rejected as scientifically unsound, unimportant (i.e. do not contribute any worthwhile information), or otherwise unsuitable for publication. Each year a few manuscripts are either withdrawn or not revised by the authors; others, if their content is borderline for *The Canadian Field-Naturalist,* are returned to the authors with the advice to submit their manuscripts to other publications.

It is encouraging to report that much of the material presently being offered for publication in *The Canadian Field-Naturalist* is of a very high scientific calibre. Nevertheless the strength of the journal lies in the reviewing of manuscripts by qualified referees. The Associate Editors of *The Canadian Field-Naturalist* are highly competent people who are experts in particular fields of biology. Each submitted manuscript is seen by an Associate Editor who either reviews it himself or asks another qualified person to do so. In addition, all articles and most of the notes are reviewed by specialists chosen by the Editor. I would like to thank the many busy people who have refereed papers for the journal. Over the past year the only major difficulty encountered has been the tardiness of some referees in returning their comments. Authors should not have to wait for lengthy periods before learning the decisions of the referees and Editor about the disposition of their manuscripts. Therefore, I am making a special plea to referees: please review and return manuscripts within the allotted time of three weeks. I know how busy you are — we are all very busy — but for the sake of the journal and the authors please do the reviews promptly.

I believe that *The Canadian Field-Naturalist* has earned a well-deserved good reputation among scientists and naturalists. This is clearly indicated by the fact that it has received financial support from the National Research Council of Canada and from The Canadian National Sportsmen's Show. Now that there is an increasing number of good manuscripts being offered for publication, I aim to keep the scientific quality and the overall standards of the journal as high as possible, while continuing to serve our authors and readers among scientists and naturalists.

LORRAINE C. SMITH
Editor

Book Review Editor

Iola Price Gruchy has been the imaginative and energetic Book Review Editor for *The Canadian Field-Naturalist* since 1971, that is for the 12 issues comprising volumes 85 through 87. During that time she solicited reviews from some of Canada's prominent scientists. *The Canadian Field-Naturalist* has published these reviews and thus brought to its readers the ideas and feelings of many persons who otherwise would not publish in journals read by the average naturalist. Iola has asked to be relieved of these duties. Thus on behalf of the Publications Committee and the members of The Ottawa Field-Naturalist's Club a very sincere thank you goes to Iola.

Anne Innis Dagg has enthusiastically agreed to be your Book Review Editor and I'm sure as readers you will see some interesting books and some critical reviews in the forthcoming issues of *The Canadian Field-Naturalist.*

J. GINNS, Chairman
Publications Committee

National Wildlife Week, 1974

In 1974, the theme of National Wildlife Week in Canada is "Preservation of Wetland Habitat," and will be observed during the week of April 8–13th. Two ideas should come to mind immediately from the adoption of such a theme. One idea is that wetlands must be important, and the other is that wetlands are endangered, inasmuch as the preservation of them is of immediate concern. The far-sighted naturalist, Henry David Thoreau, was well aware of their importance when, over one hundred years ago, he wrote: "Hope and the future for me are not in lawns and cultivated fields, not in towns and cities, but in the impervious and quaking swamps . . A man's health requires as many acres of meadow to his prospect as his farm does loads of muck . . . A town is saved, not more by the righteous men in it than by the woods and swamps that surround it."

Wetlands, by definition, are low areas inundated by shallow water, either temporarily or permanently. Marshes, bogs, deltas, potholes, wet-meadows, and swamps are typical of the variety of wetlands. They have numerous values, a very important one being their capacity to act as a water-storage area; helping regulate stream flow, preventing floods, preserving ground water, and keeping the water-table high. Additionally they contain a great diversity of plants, act as important breeding ground for waterfowl, and serve as a habitat for many other wild creatures. Drainage of wetlands has lowered water-tables, caused flooding, and destroyed large amounts of wildlife. R. F. Dasmann, in "Environmental Conservation" cautions against the destruction of water resources, advising that "short-term gains must be weighed against long-term losses."

From the standpoint of production of waterfowl, the North American prairie potholes are of immense importance. The potholes, which average one or two acres in size are numerous, often numbering from a few to 200 per square mile. The number of these "prairie ponds" in Canada was calculated by J. B. Gollop of the Canadian Wildlife Service to total nearly 4,000,000. In spite of individual small size, and in spite of the fact that the Canadian prairie pothole region makes up only ten percent of the waterfowl breeding area of North America, it produces about half of the ducks that hatch each year.

Reprinted from the Canadian Wildlife Federation's *Wildlife News* 9(4), 1973.

Raptor Research Centre Opened

Brutus, a Golden Eagle, hosted the opening on 8th November 1973 of the Macdonald Raptor Research Centre on the Macdonald campus of McGill University. The Centre, which now has a basic collection of birds of prey including Bald and Golden Eagles, Peregrine Falcons, owls, kestrels, Rough-legged Hawks and Marsh Hawks, is intended to develop means of protecting species threatened by toxic insecticides such as DDT and other environmental hazards. One of the most intractable problems of work in this area has been difficulties of breeding Peregrine Falcons (now almost extinct) in captivity. Although research work has barely begun, the Macdonald Centre has already been successful in establishing with kestrels a new breeding method with which it is hoped to overcome such problems. After the establishment of conditions in which less threatened species, especially kestrels, can be released and prosper in the wild, it is hoped that peregrines can be released under similar conditions.

The facility at Macdonald College is the second institutional research center for breeding birds of prey in captivity in Canada, and the third in North America. The first Canadian facility, the Canadian Wildlife Service Endangered Species Facility at Wainwright, Alberta, has been successful in breeding captive Prairie Falcons for the past three years. Through the use of foster parents and clutch manipulation experimental re-introduction of these birds to the wild has been pioneered. Fertile eggs have been obtained from Peregrine Falcons in captivity both naturally and through artificial insemination. Young birds should be reared in 1974.

The Canadian Wildlife Service project is unique because it combines an active field program of population surveys, pesticide residue monitoring, and the direct application of field management projects with the breeding project. Research findings are directly applied to the management of the species and all aspects are co-ordinated through a central program. All of the major facilities are in direct contact; this eliminates unnecessary duplication and ensures a co-ordinated approach. Thus this problem in conservation, which is international in scope and implication, is being tackled by these two research centers in Canada.

Alberta Ornithological Records Committee

The Federation of Alberta Naturalists recently announced the establishment of the Alberta Ornithological Records Committee (AORC) under the chairmanship of Dr. W. Ray Salt. The Committee is composed of seven members, five from Alberta and one each from British Columbia and Saskatchewan. The Alberta members will constitute the main working group of the Committee, with the out-of-province members being called upon to provide an opinion on submitted records when required.

The Federation believes that the Committee will fill a need and will provide a degree of authenticity to records of sighting and breeding of birds in Alberta. The Committee will establish standards or criteria for the acceptability of records. Alberta naturalists and visitors to the province are encouraged to submit details of observations of species of birds seen in various areas of Alberta and especially rare and unusual species of birds.

The AORC will serve as a repository for records of birds from any and all parts of Alberta. The Committee welcomes reports in any form on Alberta birds but a standardized report form called an Area List, will be printed and will be available for distribution early in 1974. All records should be sent to: The Secretary, Alberta Ornithological Records Committee, Provincial Museum and Archives of Alberta, 12845 - 102 Avenue, Edmonton, Alberta, T5N 0M6.

Notice

TO INDIVIDUAL AND FAMILY MEMBERS NOT RESIDENT IN THE OTTAWA AREA

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Book Reviews

Botany

Vegetation of the Ngorongoro Conservation Area, Tanzania

By Dennis J. Herlocker and Herman J. Dirschl. Canadian Wildlife Service, Report Series Number 19. 1972. 39 pp. $1.25. Available from Information Canada Bookstores.

The Ngorongoro Conservation Area is 3,200 square miles of reserved land, 2 degrees south of the equator in northern Tanzania. It is one of the few areas in the world that is managed and administered specifically for the integration of multiple land uses, which include wildlife and vegetation conservation, the protection of watersheds and indigenous husbandry, and the promotion of tourism. This region of Africa has been the subject of scientific survey since the beginning of this century, and now the Conservation Area is the focus of a large research effort centered at the Serengeti Research Institute.

Herlocker and Dirschl have produced a vegetation map suitable for use as basic data for the other research programs. Their method of identifying the vegetation patterns observed on aerial photographs (taken 1957/58) from surveys in the field (made 1966/67) includes an ecological component that gives the resultant map a significance beyond the purely botanical. The vegetation has been classified into five primary physiognomic categories — Forest, Woodland, Bushland, Grassland, and Herbaceous swamp — directly from the aerial photographs. The woody vegetation was then further subdivided into mapping categories from the tones and textures of the photographs. Variations in grasslands could not be directly identified, but mapping units of short-, medium-, and tall-grass dominance were interpolated from associated geographic and topographical data. The units used in the vegetation map are based on physiognomic and dominance formulae, reflecting the strata structure and species composition of the vegetation.

The report contains many good photographs which illustrate both the major vegetation types and the general character of the Conservation Area. Unfortunately no basic map is provided to show the locations and topography which are mentioned. In addition to names on the vegetation map itself, a small outline map of the area with physiographic regions and drainage systems would clarify the regional vegetation descriptions which comprise the main part of the publication.

This vegetation survey is as complete and accurate a mapping of the area as is possible to date, given its areal extent, its degree of inaccessibility, and the accuracy of local cartographic data. Its greatest use will be as a source of primary information upon which to base planning and management decisions for the development of the exciting concepts of the Ngorongoro Conservation Area.

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Zoology

Birds of Rocky Mountain National Park

By Allegra Collister. Denver Museum of Natural History, Museum Pictorial Number 18, Denver. 1970. 64 pp. $1.00.

This annotated bird checklist is the fourth since 1937 on this portion of mountainous Colorado. Accounts of the 256 bird species recorded in or near the park are concise, well prepared, and reasonably free of typing errors. The many excellent photographs by Alfred M. Bailey, Patricia Bailey Witherspoon, and others are worth the modest price alone. The booklet will be of interest primarily to persons visiting north-central Colorado, and perhaps to observers inhabiting other parts of the Rocky Mountains, who wish to compare the birds found in their areas to those elsewhere in the same mountain range. A map of the area covered by the book would have been a useful additional feature.

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Vancouver Birds in 1971

By R. Wayne Campbell, Michael G. Shepard, and Wayne C. Weber. Vancouver Natural History Society, Box 3021, Vancouver, B.C. 1972 (but date not given on book). 88 pp., 18 figures, 5 tables. $1.50.

This slim volume consists primarily of annotated species accounts of birds observed in the vicinity of Vancouver, British Columbia during 1971, although occasional habitat or behavior notes are included, and a table compares measurements from dowitchers (*Limnodromus* spp.) of both species collected in the area to such measurements from specimens taken elsewhere. Besides the usual introductory material and credits, additional sections explain sources of material used, cirteria for accepting records, and the format followed. The weather for the year is summarized, and changes of status of some species within recent years listed. Accounts of escaped and recently introduced species are in a separate section following the accounts of native and long-established introduced species. Additional features include a list of references and reports on several projects involving banding, counts, duck nesting boxes, and permanent records.

On the whole the book is carefully prepared and well documented, although it suffers from poor proof-reading, which a long list of corrections included in some (not all) copies only partially rectifies. The species accounts are well written and concise, and most of the photographs are excellent. The list of references might usefully have included the earlier publications from Vancouver and British Columbia in general, and at least some mention of the similar annual bird reports from Victoria and the seasonal reports in *American Birds*. However, these points are minor and I unhesitatingly recommend this book to anybody living in, or planning to visit, the West Coast of Canada, and to compilers and editors of the monthly, seasonal, and annual bird reports springing up all across Canada.

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The Spotted Hyena: A study of predation and social behavior

By Hans Kruuk. The University of Chicago Press, Chicago and London. 1972. xvi + 335 pages, illustrations, maps. Wildlife Behavior and Ecology Series. $15.00 (U.S.).

When I went to Africa 16 years ago to study giraffe, facilities and encouragement for wildlife research were practically non-existent. Even to be allowed to do research at a ranch where there were wild giraffe, I had to buy a car in order to be able to approach and observe the animals, and pretend in my letters of arrangement that I was a man. It is heartening to read in Kruuk's superb book on the Spotted Hyena that excellent conditions now exist for wildlife study in the game lands of East Africa. Dr. Kruuk states that he was able to use tranquilizing darts to immobilize and mark by ear clippings hundreds of hyenas; radio transmitters and a receiver to follow the daily movements of an individual (a female was tracked minute by minute for 12 consecutive days and nights); a tape recorder to capture the yells and giggles of hyenas at a kill; a loud speaker to replay these sounds and attract other hyenas; equipment for fecal analyses so he could determine what the hyenas ate; and a light aircraft to make a census of plains' animals.

The results of his three-and-a-half year research program are well set out in this book. The text alone is highly readable, and it is supplemented with more detailed results presented in the tables and figures, with peripheral data in the appendices, and with informative sketches and photographs. This new method of presenting data from field research in book form (pioneered by the University of Chicago Press) is far superior to the erstwhile common alternative — the publication of one or even of a number of technical papers which seldom, if ever, are read by laymen or even by zoologists working in unrelated fields.

Before the publication of this book, little was known about the Spotted Hyena. Now we find it a fascinating species. Kruuk discusses the hyena as

an active predator rather than as a scavenger; as a frequent pack hunter not unlike the wolf, which attacks various prey species in different ways; as an individual which competes with other hyenas at the same kill not by fighting but by speed of eating (a single hyena can consume a gazelle fawn in under two minutes); and as an animal which caches food in waterholes where it cannot be smelled nor seen by rival predators.

There are bases for the unsavory reputation of the hyena. For example, hyenas destroy their prey by devouring them alive. They bring down a zebra by eating its intestines and flesh as it flees or as it stands in a state of shock. Hyenas also devastate wildebeest calves — in the Ngorongoro Crater they kill three-quarters of those born each year. (As a countermeasure, however, the calves are born in a one-month period, as most caribou are, so that the predators are "swamped" by more individuals than they can consume at one time.) Hyenas are also not above killing and eating each other, which may explain why the female is larger than the male, dominant to him, and thus able to protect her young from him.

Kruuk, as a scientist should, suggests a number of unanswered questions. I found myself mulling over problems such as these: Why do hyenas struggle over their kill so raucously that lions may be attracted to take over the feast and thus exclude the hyenas? Why are not wildebeest calves, a favorite food of hyenas, protected against them by speed of movement or by camouflaging coloration? And why do some hyenas observe such strict clan territories that if they chase and down an antelope in a neighbouring clan's territory, they leave their meal for the neighbours' exclusive use?

For anyone more than superficially interested in wildlife, this book is well worth reading and thinking about.

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The Carnivores

By R. F. Ewer. Cornell University Press, Ithaca, New York. 1973. 494 pages. $21.50.

This is another of those books which, purportingly aimed at both layman and serious scientist, can not really satisfy either customer. While it presents a reasonable review of carnivore biology, it is often too plodding to captivate any but the most persistent lay reader. At the same time, it seldom attains the depth necessary for it to be of much use to those who regularly follow carnivore literature.

Following brief introductory descriptions of the seven carnivore families are chapters on the skeleton, anatomy of the soft parts, the special senses, food and food finding, signals and social organization, social organization and living space, reproduction, fossil relatives, and classification and distribution of the living species. The approach is basically comparative, family against family, for the various subjects covered. Additionally, differences between species are often discussed; much of this information would have been more digestible in tabular form. The book, strictly about carnivores, does not deal with comparisons between this group and other mammals.

Many readers will be disappointed by the author's decision not to include information on the dynamics of predation and carnivore populations. She felt that these subjects "take us too far away from the animals themselves and their adaptations, which constitute the main theme of the book." On the whole her efforts to synthesize the material available on the subjects she has selected are laudable. Her reviews of locomotion and feeding in relation to skeletal features, pelage, sensory capacities, hunting and killing behavior, and reproduction are all useful, and the summary tables of data on dentition, reproduction, and development are valuable. The palaeontology chapter, to me the best of all, includes recent data on species and family relationships as revealed by biochemical and chromosome morphology techniques. (Interestingly, even these sophisticated methods disagree on the degree of relationship between ursids and procyonids, and we are still not certain of where to put the pandas.) Another positive aspect of the book is the author's frequent speculation which calls at least indirectly, and often directly, for studies on specific subjects. Students of anatomy, physiology, taxonomy, and behavior will benefit most from these.

Of the impressive total of 974 references cited, 35 percent are post-1965 and an additional 20 percent appeared in 1960–65; thus the book is

current. In the event that the author plans a revision, I would like to put several of the book's shortcomings on the record.

Organization and format are weak. Subheadings within chapters are inadequate: for example, the discussion on milk dentition and the very good summary on carnivore skull characteristics (chapter 2) are both "lost" in a section headed "Hyaenidae." Of six topics listed in the chapter on soft parts, one is "Rhinarium." This is an uninspiring one-half page which concludes with the information that nose-prints can not be used as carnivore finger-prints. Meanwhile the genitalia, which one might think would deserve a subheading of their own, are discussed within a section labelled "Viscera." The 16 pages of photographs in the center of the book must have been inserted as an afterthought. Most are not particularly good, they are unattractively laid out, they appear in no logical order which I can detect, and most are not referred to in the text (a reference to plate 8 on page 196 should actually read "plate 9").

Though published in the United States, this book is British. Just 40 percent of all references cited were from North American journals or books (many dealing with species from other continents), and most of the remaining 60 percent originated from British, African, and German sources. It appears that the author has had little experience with North American carnivores, and many minor inaccuracies and errors of interpretation might have been prevented had she found someone on this continent to preview her manuscript (she acknowledges no one in this capacity). A few examples will suffice, but there are more. She insists (pp. 144 and 258) that Isle Royale supports a single pack of wolves, although even references she has cited state otherwise; we might question her conclusion (p. 152) that coyotes have been accused of livestock predation because they look like wolves; the supposed social significance of "bear trees," perpetuated by the author in this volume (p. 241) has been largely discredited; A. Murie's classic wolf studies were carried out in central Alaska, not in the Rocky Mountains (p. 258).

The author claims to follow the taxonomy of Hall and Kelson (*Mammals of North America*) although she has often departed from their classification and often with no explanation e.g. her reference to the cougar as "*Puma concolor*" and her lumping of our lynx and wolverine with the Old World species (*Lynx lynx* and *Gulo gulo* respectively).

The book's usefulness as a reference would have been enhanced by inclusion of a list of tables and a list of figures. There is an author index which appears to be total in its coverage and a subject index which is fairly complete although more plasticity in cross-referencing would have been desirable. For example, the reader interested in growth of young carnivores will find no entry under growth or development, but must look under "young, development of" to locate his subject.

Because I fear that in much of the foregoing I have implied that *The Carnivores* is bad, I wish to emphasize that this is not so. It simply is not as good as it could be. It would be a bargain at half the price.

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A Key to the Microtinae of the Pacific Northwest

By Chris Maser and Robert M. Storm. Oregon State University Book Stores, Inc., Corvalis, Oregon. 1970. 162 pp. $4.95+ $0.25 mailing charge.

The title of this book is misleading because this is far more than a simple dichotomous key to the microtine rodents of the Pacific Northwest. It is, in fact, a beautifully condensed series of life histories for each species occurring in Washington, Oregon, and Idaho all tied into a series of pertinent keys. Included for each species are description, distribution (18 maps), habitat, food, habits, reproduction, subspeciation, and skull features. Even the best trapping procedures for obtaining specimens of each species are given under a ''Special Note'' section.

There is an abbreviated glossary of terms and excellent drawings and diagrams clarifying use, mensuration, tooth patterns, skull nomenclature, and structure.

The keys are easy to use and the complete adult specimens tested keyed out very well indeed; some difficulty was encountered with immature skull-only specimens. But all in all this is an excellent, most useful piece of work.

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The Life and Organization of Birds

By W. B. Yapp. American Elsevier Publishing Company Inc., New York. 1970. 246 pp. Clothbound $11.75. Paperbound $5.95.

In this day of expensive books it is a pleasure to review a book of quality at reasonable cost. In the *Life and Organization of Birds* the reader will find his money's worth. This book contains nine chapters on varied aspects of ornithology, including the major topics of evolution, anatomy, physiology, behavior, migration, and ecology. There are few recent books with as comprehensive a coverage of the field of ornithology. The text is well written, adequately illustrated with photographs, line drawings, and maps, and is documented with an extensive list of up-to-date references. Unfortunately for North American readers the book has a European emphasis, most of the examples pertaining to the Old World.

In his preface the author makes it clear that his emphasis has been on areas of special interest to himself. This becomes clear as the reader delves into the book. First, the arrangement of the chapters and their subsections is somewhat puzzling. For example in Chapter 5, entitled "The Endocrine Control of Reproduction" subsection 5.3 deals with "Some Other Hormonal Relationships," in which the author deals with factors not directly associated with reproduction. In this section he speaks of plumage and alludes to molt. Here he could readily have discussed the hormonal control of molt but avoids doing so, and in fact makes no attempt to discuss molt in any detail at any point in his book. In Chapter 7 entitled "Maintenance Activities of Reproduction" we find subsection 7.4 devoted to "Migration." Although one cannot deny the causative relationship between breeding seasons and migration, the latter hardly classifies as one of the maintenance activities of reproduction. Basically, however, the discussion of migration is sound and contains a good critique of many of the modern experimental data. Nevertheless this section could have been enhanced had the author made some attempt at explaining avian navigation by solar and stellar means. Instead he casually mentions such theories in passing. Finally, the emphasis placed on certain topics seems unduly imbalanced. Why, in discussing reptilian characteristics of birds, are three pages devoted to the egg and only five pages to the reptilian features of the skeleton, blood system, and urinary system? Why in discussing adaptive radiation are six pages devoted to swimming and diving birds, and only three pages to the remaining "typical birds?" Surely such imbalances do not accurately portray the importance of the topics discussed.

Generally the text is accurate and illustrations clear and useful, but the book is not without its inaccuracies. On page 15 the author takes pains to point out that the procoracoid bone is commonly incorrectly referred to as the coracoid. Yet on page 17 he makes the inexcusable error of referring to the anchylosed synsacrum (fused lumbar, sacral, and anterior caudal vertebrae) and pelvis as being the synsacrum. This error is further compounded by the accompanying illustration. On page 51 the author refers to the use of wings by loons in swimming underwater. This is a commonly held misconception amongst ornithologist for which there is no documented proof. The illustrations of various avian sterna (Figures 2.4 and 3.2), are virtually unrecognizable as such. In Figures 2.1(a) and 3.4, the digits are incorrectly numbered, and Figure 5.2 a "diagram of pituitary relationships" shows the most peculiar gonads which I have seen in any vertebrate animal! Although the photographs are generally of good quality some are out of focus, e.g., Figures 2.8 and 3.8.

There are other areas where criticism could be levelled, e.g., in terms of omission. But it is easy to criticize and as the author points out, "other authors would have chosen differently." All in all it is surprising how much information has been packed into 246 pages. If one can accept the European bias and ignore the minor errors which have been referred to, this book contains much valuable information for anyone with an interest in birds.

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The Serengeti Lion

By George B. Schaller. University of Chicago Press, Chicago. 1972. 480 pp. $12.50.

Schaller studies real animals in their native habitats, and gets results. These days, when ecologists are constantly simulating, but rarely stimulating, such subversive activity (as exemplified in this book) will serve to reassure those few faithful who have suspected all along that "outside is where it's at." In short, the days of description are not over. It is not enough to trip around Africa noting that "lions" did this or that and ate everything from termites to Congolese policemen. As Schaller shows clearly, the response of any given lion to other lions or even to prey is likely to depend upon its sex, age, and residential status and, not surprisingly, an all-prey-

known list is of little consequence in any local context. By building up a backlog of familiarity with a limited (not small) number of lion groups in a specific area occupied by reasonably well-known prey, Schaller has brought a point of perspective into his work which is rarely attained in wildlife studies.

The main objective of the study was to determine the effect of lion predation on prey populations in Serengeti National Park. On the way toward a reasonable fulfillment of that objective, Schaller has amassed an impressive array of data on many aspects of the life history of lions and several other park predators. The first two chapters in the section on the lion deal in detailed and insightful manner with "group structure and movements" and "behavior within the group." Schaller acknowledges that three years, the period of his study, was too short a time "to elucidate such topics as birth patterns and mortality rates," yet his population dynamics chapter, again drawing on his intimate knowledge of the histories of many known individuals, is more credible than similar efforts I have seen for much shorter-lived animals. Central to the theme of the book are the following two chapters, dealing with "food habits" and "the hunt." These include much descriptive material as well as extensive (sometimes exhaustive) discussions on those aspects of prey life histories which make the animals vulnerable to predation by lions, together with data on the timing, extent, and effect of such predation on each. A bonus not evident from the book's title is a section providing much the same information for other Serengeti predators as that already given for the lion (over 60 pages on leopard, cheetah, and wild dog alone, with shorter summaries for hyenas, jackals, and rarer species).

A "summary and conclusions" section comprises the last 50 pages of text. Here Schaller discusses the dynamics of predator social systems and the dynamics of predation, including consideration of much current ecological theory. Drawing together the diverse data on several species which he has presented earlier, he attempts to assess the biological significance of these findings, particularly from an evolutionary standpoint. While the scientist-reader may feel compelled to quarrel with some of the assumptions and will probably not agree with all of the conclusions, he can scarcely fail to be stimulated. Ultimately, Schaller concludes that "predators are the best wildlife managers."

The book is up to the standards of quality established by the first two books in the Chicago series (Geist's *Mountain Sheep* and Kruuk's *Spotted Hyena*), a fact which is not surprising since Schaller himself has edited all three volumes. A very comprehensive index and a bibliography of over 250 titles add to the book's value as a reference, and 43 superb photographs enhance its appeal. A novel device, placement of the data tables (all 79 of them) in an appendix at the back of the book, will hopefully be registered as a publishing experiment which failed. I found it extraordinarily inconvenient, as did several other readers with whom I discussed the book.

Some readers may be bothered by Schaller's use of statistics which is, at best, inconsistent. Occasionally results are said to be statistically significant (or not), but no further information is given; at other times a probability level is listed but the test used and degrees of freedom involved remain unknown. Sometimes fine-toothed probability is given for a result which the reader would have believed anyway, such as on page 231 where a sample of 23 females and 68 males is shown to depart significantly from 1:1. More often Schaller uses no statistics at all, as on page 375 when he speaks of a "good correlation" between predator biomass and prey biomass in Table 75, a "correlation" which, incidentally, wasn't so obvious to me. Finally, the mathematical purist will object to the consistent use of equality and inequality signs in tandem (e.g., $p = <.01$). While Schaller's statistical performance at times left me uneasy, I found it on the whole less offensive than the more common situation in which an author dazzles the reader with clever analyses as a sort of compensation for destitution of data. Hopefully future students of predation will judge and test Schaller's conclusions (which he has taken full responsibility for) and not just his analytical methods.

Near the beginning of the book Schaller points out that doing the study gave him pleasure and, apologetically, he warns that the book transmits "dry facts" rather than this pleasure. He does not wholly keep his promise, partly because many of the events he describes (e.g. interactions between lion prides) are inherently exciting, and partly because when the chips are down he cannot resist turning a nice phrase or interjecting an anecdote. Thus, for example, a heavily-maned male lion is described as "looking like a moving haystack," a poacher who tried to escape from a game warden by swimming a river "was apprehended by a crocodile instead," and the Serengeti is described as "a boundless region with horizons so wide that one can see clouds between the legs of an ostrich." That Schaller is a good biologist, a good writer, and a sensitive human being are all evident in *The Serengeti Lion*.

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Arctic Life of Birds and Mammals including Man

By Laurence Irving. Volume 2, Zoophysiology and Ecology. Springer-Verlag, New York, Heidelberg, Berlin. 1972. xi + 192 pp. $14.00 (U.S.), cloth.

Laurence Irving is well known to physiologists for many years of work on low-temperature physiology of birds and mammals. He is perhaps best known to ornithologists for his studies on the birds of Anaktuvuk Pass in the Brooks Range. In this book he tries to synthesize these and related topics for a diverse readership. The early chapters deal with arctic climate and associated phenomena, habitats, Pleistocene glaciations, and origins, fluctuations and extinctions of the arctic fauna; then general accounts of arctic mammals, of arctic birds, and the maintenance of bird and mammal populations. The first five chapters, drawing largely on the work of others, sometimes lack coherence. In contrast, I found chapters 6 to 12, covering fields in which Irving has been most deeply involved, to present a clear and fascinating story.

The discussion of climate is adequate from the macroclimate viewpoint, but biologists are most concerned with climate on a smaller scale even than the meteorologist's microclimate — what we might call the nanoclimate, comprising the lowest meter, or often only 10 cm, of air. Fortunately, such a treatment is now available by P. S. Corbet (Acta Arctica 18, Munksgaard, København, 1972).

I noticed several innocuous typographic errors, but there are some more troublesome slips. In tables 3.2 and 3.3 we see reference to "several species" of *Canis lupus* and *Mustela rixosa*. On pp. 47 and 61 Theed Pearse appears as "Theed (P.)." The Urner and Storer paper cited on p. 63 is not in the references. *Calidris minutilla* and *C. pusillus (p. 64)* are in *Erolia* and *Ereunetes* on p. 65. (Fortunately the A.O.U. has now submerged these genera in *Calidris*, in line with European usage.) On p. 70 a table compiled from Savile and Oliver's account of Hazen Camp birds and mammals omits *Lagopus mutus* and *Sterna paradisaea* from nesting species; this paper (Canadian Field-Naturalist 78: 1–7. 1964) is not in the references. Isachsen (p. 72) is at 78°47′ N rather than 73°. On p. 116 the symbol for *Acanthis flammea* is RP in the figure but CR in the table. When an author writes, rewrites, and repeatedly rearranges familiar items, it is increasingly hard for him to read every word in the final version as the mind leaps ahead. This series of volumes is stated to have a managing editor, four editors, and 12 co-editors. Surely this galaxy of talent might have caught such slips and also helped to unify some of the early chapters and smooth out a few awkward sentences.

Now let me make some constructive comments on this valuable summary of a fascinating and timely theme, to aid readers unfamiliar with arctic biology. The most useful definition of the terrestrial arctic (p. 8) is simply the land beyond the last trees; this is less naïve than it may seem, for the trees control the microclimate as much as the climate controls the tree-line. Snow-cover (p. 14) is also critical because, without a certain depth, lemmings do not achieve breeding condition; hence, I suspect, their irregular fluctuations in arid high-arctic valleys. In connection with the postglacial immigration of birds and mammals (pp. 35, 53), we must realize that melting a continental ice-sheet, with a high albedo, takes much greater heat than is needed merely to keep land ice-free. Thus hypsithermal conditions *produced* the ice retreat rather than simply followed it; and growing conditions were generally good on all ground almost as soon as it was ice-free. We often underestimate plant migration rates, but we know that many species were fully 200 miles beyond today's limits far back in the Hypsithermal Interval; and early spread of animals was thus expedited. One function of the male Rock Ptarmigan's prolonged white plumage (p. 70) seems to be the "altruistic" one of distracting predators from the cryptic, close-sitting hen. The cock molts with a rush at about the end of incubation. Under insulation of birds (p. 106) more emphasis might be placed on the evident fact (not experimentally determinable because plumage of a detached skin cannot be "fluffed") that the insulation value of a chickadee's erected coat (perhaps 10 mm) is as high as that of the 50-mm pelage of an arctic fox. Thus small birds can survive in weather so cold that small mammals, unable to manage a long coat, must stay in shelter. The superb insulation provided by the interlocking feather elements gives clothing designers no cause for complacency. On p. 164 Irving echoes other zoologists' doubts about Bergmann's rule (that the largest races should occupy the coldest regions), pointing to the small size of the high-arctic Peary Caribou. Simple arithmetic assures us that the smaller of two similar bodies has the higher ratio of surface-to-volume and thus the greater heat loss; but other factors may be more critical than modest extra heat loss. Reduction of adult body size with limited food supply has been documented for some deer and is a probable cause of the small size of some island populations. Food supply is extremely short on many high-arctic islands, probably making small size strongly adaptive. The high-arctic *Gavia stellata* is also much smaller than the more southerly loons, *G. adamsii* and *G. immer*, for which

there are certainly two good reasons: it is critically important that the young can fly before the nest pond freezes, and presumably the small species fledges fastest; perhaps more importantly, only quite small ponds, from which a large loon could not take off, routinely become ice-free in the high arctic.

Irving rightly concludes that there are no major specifically arctic adaptations. The arctic fauna, like the arctic flora, is young and attenuate, made up from various alpine and temperate sources. There are no fully arctic genera, a few arctic species, and many arctic subspecies. The adaptations are mostly refinements of ones seen outside the arctic. The most conspicuous genetic adaptations are these: first, superb insulation; and second, heat-economy devices, notably highly developed counter-current heat exchangers in limbs and tails, whereby the outgoing arterial blood gives up most of its heat to the returning venous blood. Additionally, there is ample evidence for important degrees of acclimatization (non-genetic conditioning) of birds and mammals, such as is now known to occur in plants. We all experience cold-conditioning to some extent. How sharply we feel those first cool days in November (complaining of the damp, however dry the air), yet by January we cheerfully withstand much severer cold with no heavier clothing.

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Cadmium in the Environment — A toxicological and epidemiological appraisal

By Lars Friberg, Magnus Piscator, and Gunnar Nordberg. Karolinska Institute, Stockholm, Sweden. CRC Press, Cleveland, Ohio, 1971. 166 pp., 37 tables, 50 figures, and 4 plates. $25.00. Also available from the National Technical Information Service, U.S. Department of Commerce, PB-199 795.

This book was the first comprehensive work on the role that inorganic cadmium plays in the environment. It was most welcomed by physiologists, biochemists, ecologists and physicians, as well as engineers involved with environmental problems. This book focuses on the toxic action of cadmium and its effects on man and animals. The world had its mercury panic a few years ago and now the focus is on cadmium. This publication helps to put the effects of cadmium into proper perspective. It is known that cadmium is one of several factors in Itai-itai disease and has potential long-term effects on kidney function, while the research regarding possible relationship to hypertension has led to contradictory conclusions. This book and subsequent publications indicated below do an excellent job of summarizing the work to date and indicating the amount of research still required on this topic.

I must say, before going further in the review, that since this book appeared two other important publications on the same subject have been published. The first is *Cadmium in the Environment,* II, February 1973, 147 pp. by the same three authors plus T. Kjellstrom also from The Karolinska Institute, Department of Environmental Hygiene, Stockholm, Sweden. This book is also distributed by the NTIS, U.S. Dept. of Commerce, PB-221 198. The second "bible" on the subject is entitled *Cadmium the Dissipated Element,* January 1973, by W. Fulkerson and H. E. Goeller of the Oak Ridge National Laboratory, Oak Ridge, Tennessee. This bound edition of 473 pages is coded ORNL NSF-EP-21. The Karolinska Institute teams also contributed to this very exhaustive and valuable document.

It is the opinion of some analytical chemists that the Friberg 1971 edition, Chapter 2, dealing with problems of analysis, is relatively poor. No mention of technique as the anodic stripping voltametry is discussed. The other conventional methods are covered in only 3.5 pages. Based on the fact that all the rest of the book is based on levels of cadmium in air, soil, water, food stuff, human and animal tissue, etc., more thought should be given to the most reliable analytical techniques.

The Table of Contents indicates the wrong page numbers for all chapters. Because of the high price of the book such mistakes should be avoided.

The biomedical orientation of the book is well shown by the main chapters' titles: metabolism, respiratory effects and dose-response relationships, systemic effects and dose-response relationships, carcinogenic and genetic effects, the itai-itai disease. The value of the book is without any doubt enormous but the biologist certainly needs more information on the bioaccumulation of cadmium in the lower vertebrates and invertebrates. This is my major criticism. The effects of this metal in the lower animals and plants which are closer than man to the basis of the food chain are still unknown. This is partly why there are no standards as yet with respect to the cadmium content of food in the United States and Canada. It is well emphasized in the Friberg *et al.* book that severe gaps exist in the understanding of cadmium intoxication and on the turnover of cadmium in the biosphere. Accumulation via air and water in food chains should become a priority

for field biologists and analysts. Concerning cadmium in food, a recent leaflet of 31 pages published by the English Ministry of Agriculture, Fisheries and Food in 1973 and entitled *Survey of Cadmium in Food, Working Party on the Monitoring of Foodstuffs for Heavy Metals* (fourth report), gives a good basis for comparison of cadmium levels in food. A provisional tolerable weekly intake of 400–500 micrograms per adult from food and beverages is proposed.

The book is well documented with 405 references (alphabetical order). From the abundant references, the reader realizes rapidly that the data presented are based on a literature survey. This is a review of the state of the situation and the authors should not be blamed for the gaps reported before.

The authors have given a complete review, and the scientific world as well as the public are now aware of that "new" impact. I recommend this book to anyone interested in human and animal health, which is bound to the health of our biosphere. Many peculiarities reported (e.g., cadmium in cigarettes, excretion of cadmium via hair, cadmium-induced testicular necrosis, and influence of chelating agents on cadmium) make the book of high interest to any environmentalist.

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S.O.S. Biosphère: Pollution

Par Clément H. Rondeau, Collège Ahuntsic, Montréal. Éditions Hurtibise HMH, Ltée, Montréal, Québec. 1972. 155 pages, $3.00

Dans ce volume d'intérêt général et principalement orienté sur la pollution atmosphérique (plus de la moitié du contenu) se chevauchent des chapitres aussi variés que: psychologie et environnement, éducation et environnement, pollution de l'esprit et du corps, étude du plomb et ses effets biologiques, étude sur le monoxyde de carbone, ainsi que beaucoup d'autres sujets formant les vingt-et-un chapitres.

On s'attend, avec un tel titre, que l'auteur traite des problèmes de pollution dans les trois sphères de la biosphère soit l'air, l'eau et le sol. Ces deux derniers environnements sont très peu traités dans ce livre et laissent place à des chapitres tels: additifs chimiques dans les aliments et quelques-uns de leurs effets; les Nations-Unies comme policiers; qui paie la note de la pollution et de la Conférence de Stockholm. De tels titres de chapitres ont sans doute lieu d'être dans ce volume à multiple facettes mais non au détriment des problèmes de pollution des eaux et des sols. En somme, il est de mon avis que le titre n'est pas en relation avec le contenu du volume car la biosphère est définie comme étant la portion de terre qui contient les organismes vivants et dans laquelle les écosystèmes fonctionnent. Dans cet optique, certaines portions de l'hydrosphère, de l'atmosphère ainsi que de la lithosphère font partie de la biosphère.

Le texte est généralement bien documenté (91 titres dans la bibliographie) et un glossaire de six pages est annexé. Les citations de différents auteurs semblent nombreuses mais il est préférable qu'il en soit ainsi. Le lecteur réalise ainsi l'honnêteté de Monsieur Rondeau qui ne s'est approprié d'aucune citation ou déclaration.

En dépit de certaines lacunes énumérées précédemment, ce volume est à recommander principalement aux étudiants des CEGEP, aux universitaires ainsi qu'au public en général. De telles publications ne peuvent que disséminer l'information nécessaire à une prise de conscience collective sur les problèmes que l'homme cause à son environement vital.

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Watchers at the Pond

By Franklin Russell. McClelland and Stewart Ltd., Toronto/Montreal. 1961 (reprinted 1972). 265 pp. $6.95.

This is a fascinating book depicting the seasonal changes in plant and animal life in, over, and under a pond. The hypothetical pond, located in southern Ontario, is realistically described. Emphasis is on the animal life, particularly the smaller forms such as insects and the microscopic bryozoans, etc., and the birds, mice, rabbits, and shrews are all portrayed. The effects of extremes in weather, such as thunderstorms, blizzards, and drought are shown to be a major cause of mortality in the life around the pond.

The author appears to be first a writer then a naturalist. Anyone who is a fan of the flowery adjective will enjoy this book. The writer successfully overwhelms the reader in sheer numbers. For example, in the description of the fall migration one reads, "thirty thousand crows passed one day. The next day, another twenty thousand passed, and forty thousand the next day, and twenty thousand the

next day, and then fifteen thousand and thirty thousand and fifty thousand, ...'' There are occasionally inaccuracies in the text. For example, the typical summer behavior patterns of a bird are reported as occurring when the trees are in fall color, and the searching for and acquiring of a particular seed by a species of bird is carefully described but I can't find elsewhere, reference to the bird using that species of seed as food. My major complaint, however, is the author's poor choice of verbs. To describe ''sleeping'' seeds (p. 27) and leaves being ''eaten'' by fungi and bacteria (p. 245) are usages which oversimplify physiologically unique and fascinating processes which are the subject of tomes.

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THE CANADIAN FIELD-NATURALIST PUBLISHED BY **The Ottawa Field-Naturalists' Club**

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The CANADIAN FIELD-NATURALIST

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The objectives of this Club shall be to promote the appreciation, preservation and conservation of Canada's natural heritage; to encourage investigation and publish the results of research in all fields of natural history and to diffuse information on these fields as widely as possible; to support and co-operate with organizations engaged in preserving, maintaining or restoring environments of high quality for living things.

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Cover photograph: Collared lemming, *Dicrostonyx groelandicus groelandicus*, from Churchill, Manitoba, by Donald A. Smith. See articles on pages 151 and 197.

The Canadian Field-Naturalist

VOLUME 88 APRIL-JUNE, 1974 NUMBER 2

The Botany and Natural History of Middle Springs Swamp, Banff, Alberta

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#4, 908-17 Avenue, S.W., Calgary, Alberta T2T 0A3

Marsh, A. H. 1974. The botany and natural history of Middle Springs Swamp, Banff, Alberta. Canadian Field-Naturalist 88: 129–140.

Abstract. Middle Springs Swamp, a small area of mineral water seepage and tufa deposits near the center of a proposed major residential development of Banff townsite, Banff National Park, Alberta, is described. The mineral water and the resultant friable tufa of the "Swamp" are from probably the same geological structure as that of the thermal mineral springs in the same locality. Four vegetation habitats on this unusual substrate are recognized: seepage, flowing water, banks, and well-drained tufa. The flora of 193 species, consisting of 22 algae, 11 liverworts, 22 mosses, 35 lichens, and 103 vascular plants is reported by habitat. A historical sketch of the region notes the activities of early travellers and botanists.

Introduction

The small area of mineral water seepage and tufa deposits, known locally as Middle Springs "Swamp," lies within a proposed major residential development of the expanding town of Banff, in Banff National Park, Alberta, and will be destroyed by such development.

The Swamp is interesting because of its rich floral diversity, associated with the unusual substrate. The *Carex* and orchid floras are especially noteworthy.

The preservation in its natural state of this unique, botanically and geologically fragile feature is desirable.

This examination of Middle Springs Swamp was undertaken at the suggestion of the former Chief Naturalist, Banff National Park, Mr. E. B. Cunningham (see Cunningham 1970).

History of the Region

Native peoples have lived in, and traversed, the Bow River Valley and the adjacent plains and mountains for about 12,000 years (Christensen 1969). Although the recent prehistory of the area is imperfectly known, the Kootenay Indians appear to have occupied the general region until the late 18th century or the early part of the 19th century, and to have been superseded by a Blackfoot group, which was in turn replaced by the Crees, and they by the Stoney Indians, who have been resident in the area from the mid-19th century (O. A. Christensen, personal communication; Dawson 1886; McDougall 1899).

Sir George Simpson (1847), Governor-in-Chief of Rupert's Land, passed by what is now Banff, in August 1841. His "very indefinite" narrative, as reconstructed by Dawson (1886), indicates that he travelled on the north side of the Bow River at this point. Reverend Robert Rundle, Methodist missionary, entered the mountains by the Bow River Valley at the end of June 1847 (Rundle, no date). He passed by Cascade Mountain on his way to Devil's Lake (Lake Minnewanka) and left the mountains by Devil's Gap. In 1858, and again in 1859, James Hector, M.D., geologist of Captain Palliser's expedition, passed westward through this part of the Bow Valley (Palliser 1863). He camped on the "beautiful little prairie at the base of the 'Mountain where the water falls' " and to which an old Stoney Indian, whom he had met previously at Old Bow Fort, said he had guided Rundle. Dr. Hector viewed Bow Falls and, on both trips travelled on the north side of the Bow River. The Earl of Southesk (1969) passed down the Bow Valley in 1859, about 10 days after Hector's passage in the opposite direction.

None of these early travellers, including James Sinclair of the Hudson's Bay Company, in 1841 (Lent 1963), and Father DeSmet, Jesuit missionary, in 1845 (McGuiness 1967; Thwaites 1906), who crossed the Rocky Mountains by what is believed to be White Man Pass and present-day Canmore, mentioned the thermal mineral springs south of the Bow River at Banff, although some of them were aware of similar springs within several hours' and several days' journey of this place.

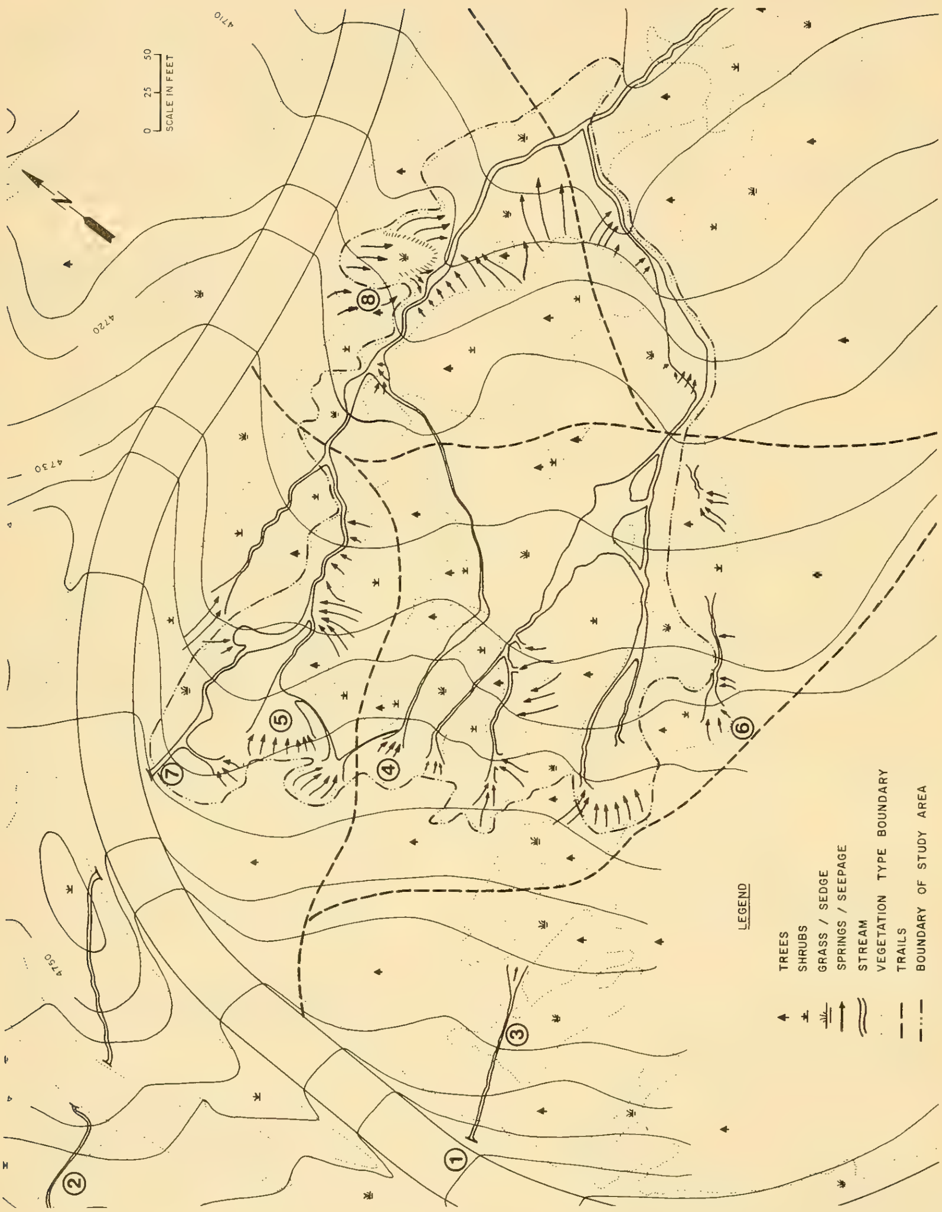

FIGURE 1. Middle Springs Swamp on the lower north-east slopes of Sulphur Mountain near the south-west edge of Banff townsite, Banff National Park, Alberta. Part of Mountain Avenue, connecting Banff townsite with the Upper Hot Spring, is shown skirting the north side of the Swamp. Numerals 3 to 8 indicate the sites of collection of water samples in the Swamp (see Table 1). Sites 1 and 2 indicate samples at the source of the respective streams.

On August 7, 1883, three prospectors, William and Thomas McCardell and Frank McCabe explored the hitherto unrecorded, although later strongly contested, Cave Spring and the Basin Spring (Layzell 1963; Liddell 1962). Their application for lease for commercial development of the springs led to an Order in Council of November 25, 1885, reserving the springs and surrounding land to the Crown (Burgess 1887; White 1887). This reservation of 10 square miles, centering about the springs, was the embryonic Rocky Mountains Park, later Banff National Park.

Contrary to the imaginings of some writers, the springs were not of great interest to the Indians, and this may account, in part, for the early travellers' lack of awareness of them. The McCardells and McCabe found the "beautiful circular basin jammed full of fallen timber" and they "found no signs of the Indians having been there" (Liddell 1962). John McDougall (1899), Methodist missionary to the Stoney Indians, in a letter to N. B. Sanson, Banff, advised that, although the Mountain Stoneys and the *Rocky Mountain People* (Cree Indians) before them, knew of the " 'Hot water that came out of the Mountain' and used the sulphur crustation for medicinal purposes," they neither bathed in the springs nor had any superstitions concerning them. Likewise, the aged, rheumatic grizzlies that visited the springs to soak away their aches did so only in the imaginations of the tourist promoters.

Natural History Studies in the Area

Dawson (1886) was the first to discuss, in some detail, the geology and geography of the Banff area. He noted that "The first published geological information for this part of the Rocky Mountains is that contained in Dr. Hector's reports and journals" and he recognized the "great general accuracy and value of the work done by Dr. Hector, whether geographical or geological." Merely mentioning the thermal springs on Terrace Mountain (Sulphur Mountain), Dawson noted that they were already well known. He located the thermal springs on his *Geological Map of Part of the Cascade Coal Basin.* McConnell (1887) reported that "The springs are closely connected with a great fault which runs along the eastern base of Terrace Mountain with a displacement of over 5000 feet."

Warren (1927) made a detailed stratigraphic and paleozoologic survey in the immediate vicinity of Banff during the summer of 1923. His study, which centered upon an investigation of the thermal springs, was occasioned by the cessation of flow of the Upper Hot Spring during March and April of 1923. He confirmed that the springs on Sulphur Mountain are in the immediate vicinity of the Sulphur Mountain Fault and that the temperature of the water is induced by deep circulation along a fault. Warren described the Middle Springs, at that time, as being among those having a high temperature but also noted that "Cold water springs are of rather common occurrence at the base of the mountain, especially along the fault . . ." Haites (1959) agreed with Warren that the decrease in temperature of the springs along the fault, and with decreasing altitude, is probably due to the admixture of cold waters, and he considered this to account also for the chemical variations of the spring waters. He postulated that the thermal mineral springs have their source in Sundance Creek, two miles to the southwest, that the water travels to considerable depth by the Bourgeau Fault, and returns to the surface by the Sulphur Mountain Fault. Van Everdingen (1972), however, has pointed out that "It is much more likely that the water of the thermal springs . . . represents infiltration over a large part of Sulphur Mountain."

Water from the Middle Springs served the sanitarium built in 1886–1888 on the site of the present Park Administration Building (van Everdingen 1972) three-quarters of a mile ENE of the Middle Springs. The sanitarium, and a bottling works behind it, was built by Dr. R. G. Brett, Canadian Pacific Railway construction surgeon and later Lieutenant-Governor of Alberta. Warren's (1927) report that, at the time of his study in 1923, no attempt had been made to utilize the water from the Middle Springs, indicates that either the use of this water by the Brett Sanitarium left little mark on the Middle Springs or that, more likely, the water had been drawn from below the Springs. The moss-covered remains of a once-fenced, open, stone cistern at the spring-source of stream Site 1, (Figure 1), half-way between the Middle Springs and the Swamp are a mute reminder that this water was bottled by Dr. Brett as *Banff Lithea Water*. "It crashed" (F. O. Brewster, person communication). Water for the sanitarium may also have come from this source.

During probably the early 1940's, the Middle Springs were impounded and the water was piped to the fish hatchery (F. O. Brewster, personal com-

FIGURE 2. Aerial view of Middle Springs Swamp from the north-west. The light areas are sparsely-vegetated tufa. Water flow is from the primary seepages at the Swamp–forest border on the right, toward the left.

munication). The mineral water was found to be unsuitable for the purpose and its use was soon discontinued. The stream course and volume from the Springs did not return to its former pattern after abandonment of the impoundment; indeed, the beautiful Middle Springs portrayed by Elworthy (1918) are almost unrecognizable today.

The first known botanizing in the region was by Mons. M. E. Bourgeau, botanist of the Palliser expedition who, in August 1858, travelled up the Bow River Valley (Palliser 1863) to within 20 miles of Banff, where he made extensive collections (Macoun 1883). In September 1879 John Macoun, Dominion Botanist, "ascended the Bow River Pass for a few miles" above Old Bow Fort "and obtained some knowledge of the alpine flora" (Macoun 1883). In 1885 the new railway enabled Macoun to visit Banff and to collect at Canmore and at Castle Mountain (Macoun 1922). In his wide-ranging trip to the region in 1891, Macoun again visited Banff, this time to botanize. He collected both vascular and non-vascular plants from "Damp springy places on Sulphur Mountain" and from "Near the Middle Springs."

Norman B. Sanson collected assiduously in the Banff area, especially on Sulphur Mountain. In his dual role of meteorological officer and curator of the Government museum at Banff from 1896 to 1931, he made 1000 official ascents to Observation Peak, at 7495 feet elevation on Sulphur Mountain (Adams 1970), and many of his collections of both vascular and non-vascular plants were made along this route, from "Side of Trail." Sanson collected also from "Overflow Middle Spring" and from "Wet places, close to Middle Springs." Many of his vascular collections were determined by P. A. Rydberg.

In 1912 and again in 1928, August H. Brinkman collected liverworts from the caves and environs of Middle Springs. In 1923, 1925, and 1927 Fay A. MacFadden collected mosses from "near the sulphur springs, Middle Springs Camp." Since then, many professionals and non-professionals have botanized in the Banff area.

Representative vouchers of the Brinkman, MacFadden, Macoun, and Sanson collections are deposited in the University of Calgary.

Description of the Area

Middle Springs Swamp is on the lower northeast slopes of Sulphur Mountain at 115°34′30″ W, 51°09′50″ N (Figures 1 and 2). It is one-eighth mile west of the present southwestern limit of residential development of Banff townsite (Figure 3) and one-

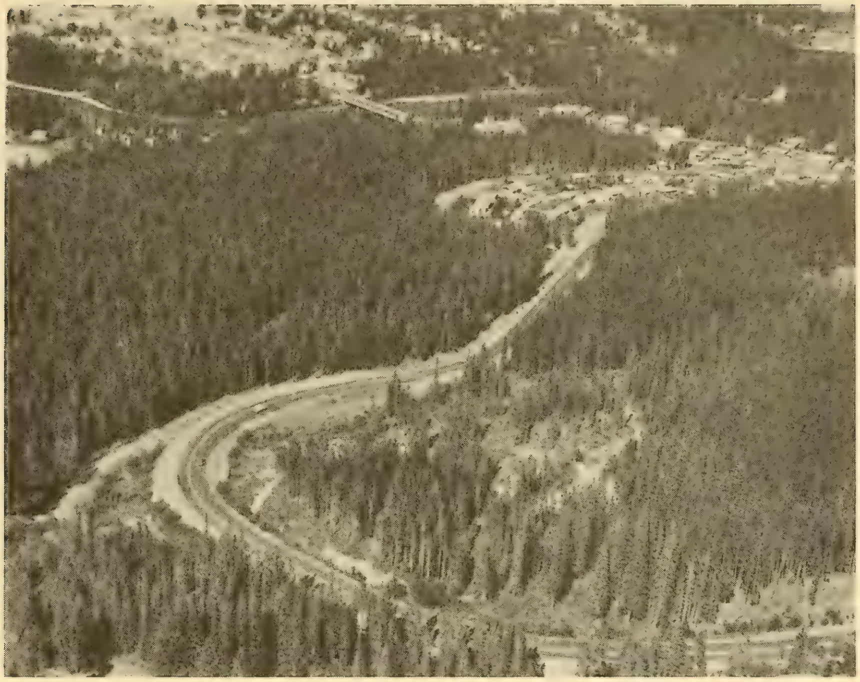

FIGURE 3. Middle Springs Swamp, seen in the sickle of Mountain Avenue, is within a planned major residential development of Banff townsite. It is one-eighth of a mile west of the present south-western limit of residential development and three-quarters of a mile from the commercial area to the north-east (upper left) across the Bow River.

quarter mile east of the Middle Springs. The Swamp is roughly triangular, about 3½ acres in size, and ranges in elevation from 4700 to 4750 feet.

Middle Springs Swamp is characterized by mineral water seepage and by tufa (travertine) deposits (Figure 2). The tufa is thought to compare closely with that of the deposits at the Upper Hot Spring, the Kidney Spring, the Cave Spring, and the Basin Spring (Elworthy 1918; R. O. van Everdingen, personal communication; van Everdingen 1972). These deposits are composed of 98% calcium carbonate, less then 2% insoluble material (mostly silicates), and less than 1% organic matter. The dry tufa, on the higher, well drained area between the major water courses in the Swamp, forms physically firm deposits (Figure 2). The seepage areas are unstable, having much decomposed organic matter mixed with marl, all of which is buoyed up by the seepage (Figure 4).

The dry tufa deposits are composed of particles of two physical types: (*a*) hard nodules up to 8 mm long and 2 mm thick, formed during annual high water by the repeated deposition of calcium carbonate about nuclei as the cool spring-water flows over the insolated surface, becomes warmed, and yields its carbon dioxide; and (*b*) friable units up to 3 cm wide, formed during low-water periods by capillarity to the warm surface, evaporation, and the deposition of calcium carbonate on particles. The ultimate size of the fragile units is dependent upon their freedom from disturbance.

Although the general geology of the Banff area and of the thermal mineral springs is understood, that of the Swamp is imperfectly known and the exact source of its water is uncertain. The two streams entering the Swamp (Sites 1 and 2, Figure 1) flow from cool-to-cold springs in the mountain half-way between the Middle Springs and the Swamp. Whether this water comes from the Sulphur Mountain Fault and, if so, whether it rises to the exposure of the fault before surfacing, is not known. Stream 1, (Figure 1) which has the major influence on the Swamp, has at its source a strong odor of hydrogen sulfide, indicating probably-deep penetration of the water in an anaerobic environment, and a rapid ascent of this water through the

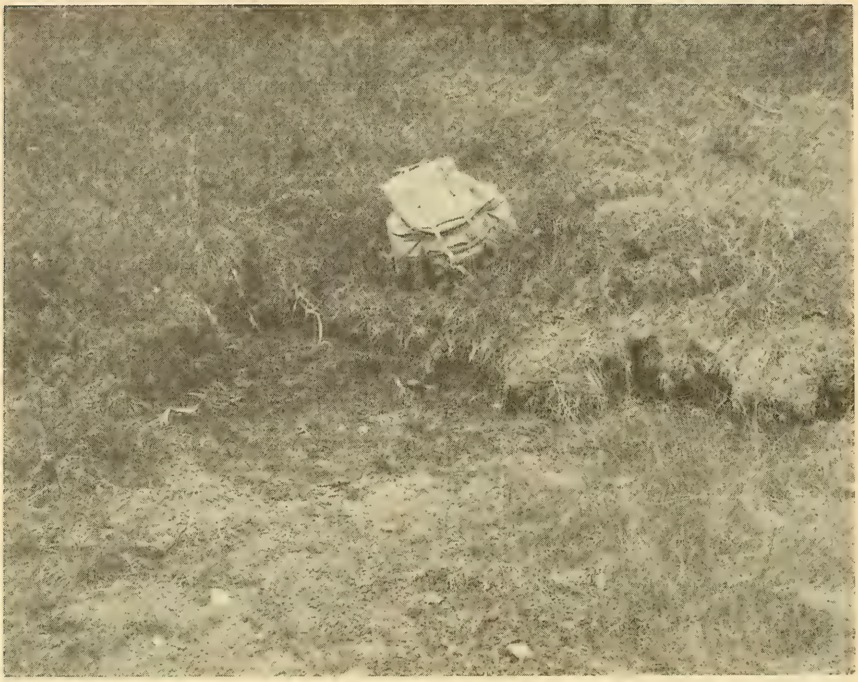

FIGURE 4. A secondary seepage adjacent to the stream flowing through the north part of the Swamp.

near-surface aerated zone. This water cannot be repercolated Middle Springs water. The degree of dilution of the (probable) thermal mineral water by cold surface water is also not known (van Everdingen 1970).

Van Everdingen (1970) has shown that there is a wide annual variation in the flow, temperature, and dissolved solids content of the water from the Upper Hot Spring and the Cave Spring. Table 1 shows the high sulfate ion content of the water flowing into the Swamp at the close of the annual low-water period, on April 28, 1971, that is indicative of water that has had prolonged subsurface flow. Sample 6, (Figure 1) has a sulfate ion content characteristic of the water from the hot springs, following the sudden increase in discharge about mid-May (van Everdingen 1970), and indicates that this water has a large proportion of surface or near-surface flow which is probably run-off from the slopes to the south of the Swamp, rather than spring water. The bicarbonate content of Sample 6 corresponds with the increase of this ion in the hot springs effluent during the period of high dilution. Sample 8 has the chemical characteristics of water that has had little or no surface flow. It is probably water from source 2, which may have flowed beneath the road to its point of emergence in the Swamp.

Haites (1959) reasoned that the tufa deposits at the orifices of the major springs have formed since the retreat of the Cordilleran ice, and that the present

TABLE 1 — Sulfate, bicarbonate, and approximate dissolved oxygen content of water entering Middle Springs Swamp at several points, on April 28, 1971. Samples 1 and 2 were collected at the source of the streams entering the Swamp. Samples 3 to 8 were collected at the points shown in Figure 1. The samples were analysed by the Analytical Laboratory, Environmental Sciences Centre, University of Calgary.

Sample	Dissolved oxygen (ppm, approximate)	Sulfate (ppm $SO_4^{=}$)	Bicarbonate (ppm as $CaCO_3$)
1	8	495.0	155.0
2	9	590.0	117.0
3	11	455.0	194.0
4	9	575.0	120.5
5	10	545.0	122.0
6	10	345.0	184.5
7	9	480.0	142.0
8	8	450.0	158.0

flow of water is insufficient to account for these deposits, indicating a diminishing supply of water during their formation.

The volume of water flowing through the Swamp varies seasonally and annually. During April (of 1970) the flow is minimal, and in early May (of 1971) a fan of ice, up to a foot thick, built up from the run-off along the south margin of the Swamp, may remain over the watercourse in the south-central part of the Swamp. Following a winter in which there has been adequate recharge, high water occurs from the latter half of May to the end of June. This corresponds with the fluctuation, reported by van Everdingen (1970, 1972), of the thermal mineral springs on Sulphur Mountain, which respond to snowmelt. During this period there is extensive surface flow, especially where seepage debouches onto places of gentle relief and coalesces into minor streams. The well-drained central part of the Swamp remains moist to dry on the surface. By the end of July all flow is restricted to the main water courses which continue to flow freely, and the surrounding tufa surfaces become hot on clear days.

The urbanization of Middle Springs Swamp will require the gathering of the mineral water before it enters the Swamp and its disposal by either diversion, causing environment alteration at both the present and new dispersion sites, or by conduction in an artificial channel through the Swamp. The depth to bedrock or to a firm substrate beneath the Swamp, and the ground-water content of the intervening tufa, are unknown. The most difficult water problem for developers might be the control, especially in winter, of the fresh-water run-off from the slopes south of the Swamp.

Plants of the Swamp Habitats

The plant collections were made weekly, from May 23 to August 18, 1969. Several collections of liverworts and mosses were made in 1970 under the guidance of Dr. C. D. Bird, Department of Biology, University of Calgary.

The voucher specimens, except for the algae, are on deposit at the Herbarium, Banff National Park. An annotated plant list has been placed in the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada, K1A 0S2, from where it is available at nominal cost.

The nomenclature and author citation for the algae is that of Smith (1950), Patrick and Reimer (1966), Prescott (1962); for the liverworts is that of Schuster (1953, 1969); for the mosses is that of Crum et al. (1965); for the lichens is that of Hale and Culberson (1970); and for the vascular plants is that of Moss (1959).

Four habitats occur in the Middle Springs Swamp (Figure 2): seepage, flowing water, banks, and well-drained tufa.

(1) Seepage. The primary seepages occur along the west edge of the Swamp where the Swamp is sharply delineated from the forest by a cutbank about 2 feet high. These sites of marl and organic ooze extend about 15 feet from the bank and are characterized by *Cardamine pensylvanica* Muhl., with an associated variety of less abundant wetland plants: *Equisetum arvense* L., *E. hyemale* L. var. *affine* (Engelm.) A.A.Eat., *Carex gynocrates* Wormsk., *C. vaginata* Tausch, *Ranunculus cymbalaria* Pursh, *Parnassia fimbriata* Konig, *P. parviflora* DC., *Viola nephrophila* Greene, *Primula mistassinica* Michx., and *Taraxacum officinale* Weber. The alga *Lyngbya* sp. is found in the marl.

Secondary seepages occur along the stream banks where the percolated primary seepage reappears. The secondary seepages along the north stream are individually much smaller and more abruptly drained than the primary areas but are equally unstable within their confines (Figure 4). In these cool, wet, shaded, secondary seepages are found the liverworts, *Lophozia* sp., *L. collaris* (Nees) Schust., *L. excisa* (Dicks.) Dum., *L. porphyroleuca* (Nees) Schiffn., *Saccobasis* cfr. *polita* (Nees) Schiffn., *Blepharostoma trichophyllum* (L.) Dum., *Riccardia pinguis* (L.) S.F.Gray, *Preissia quadrata* (Scop.) Nees; and the mosses, *Distichium capillaceum* (Hedw.) B.S.G., *Gymnostomum recurvirostrum* Hedw., *Campylium stellatum* (Hedw.) C.Jens., and *Cratoneuron commutatum* var. *falcatum* (Brid.) Mönk. *Selaginella selaginoides* (L.) Link is found here.

The secondary seepage in the streams fork in the east part of the Swamp is extensive, unstable, and sparsely vegetated by mosses and herbs.

Marchantia polymorpha L., *Bryum* sp., *Philonotis fontana* (Hedw.) Brid., *Drepanocladus aduncus* var. *polycarpus* f. *gracilescens* (B.S.G.) Mönk., *Carex rostrata* Stokes, *Geum macrophyllum* Willd., and *Achillea millefolium* L. were found in seepage with restricted drainage (Site 8, Figure 1).

FIGURE 5. Minor watercourse of coalesced seepage from springs, flowing over the well-drained tufa. In the shallow, seasonal waterflow are aquatic mosses and emergent vascular plants. *Betula glandulosa, Potentilla fruticosa,* and the small, unthrifty *Picea glauca* dot the well-drained tufa.

(2) Flowing water. The minor and ill-defined water courses flowing seasonally over the well-drained tufa, from their sources within the area of coalescence of spring flow to their mouths in the major streams (Figure 5), are an extensive niche for a variety of aquatic bryophytes and emergent vascular plants.

In the minor water courses are found the liverworts, *Lophozia ventricosa* (Dicks.) Dum. and *Plagiochila asplenioides* (L.) Dum., and the mosses *Fissidens grandifrons* Brid., *Distichium capillaceum* (Hedw.) B.S.G., *Gymnostomum recurvirostrum* Hedw., *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb., *Cratoneuron commutatum* var. *falcatum* (Brid.) Mönk., *C. filicinum* (Hedw.) Spruce, *Drepanocladus revolvens* var. *intermedius* (Lindb. ex C. J. Hartm.) Richs. & Wallace, and *Tomenthypnum nitens* (Hedw.) Loeske.

The vascular plants of the minor water courses are *Equisetum variegatum* Schleich., *Triglochin maritima* L., *T. palustris* L., *Agrostis alba* L., *Calamagrostis inexpansa* A. Gray, *Oryzopsis asperifolia* Michx., *Phleum pratense* L., *Carex aurea* Nutt., *C. buxbaumii* Wahlenb., *C. flava* L., *C. lasiocarpa* Ehrh. var. *latifolia* (Böck.) Gleason, *C. scirpoidea* Michx., *C. viridula* Michx., *Eleocharis pauciflora* (Lightf.) Link var. *fernaldii* Svenson, *Scirpus caespitosus* L. var. *callosus* Bigel., *Juncus drummondii* E. Meyer., *J. saximontanus* A. Nels., *J. tracyi* Rydb., *Prunella vulgaris* L., *Aster adscendens* Lindl., *A. ciliolatus* Lindl., and *A. eatonii* (A. Gray) Howell.

In the two main streams flowing through the Swamp (Figure 6) are found a variety of attached and free-floating algae: *Zygnema* sp., *Mougeotia* sp., *Cosmarium* sp., *Closterium* sp., *Chara globularis* Thuill., *Synedra* sp., *S.* cfr. *radians* Kutz. var. *radians, S.* cfr. *tenera* W.Sm. var. *tenera, Achnanthes* sp., *Navicula* spp., *Pinnularia* spp., *P.* cfr. *viridis* (Nitz.) Ehr., *Gomphonema* sp., *Cymbella* spp., *Epithemia* sp., *Rhopalodia* sp., *Denticula* sp., *D. thermalis* Kütz., *Calothrix* cfr. *breviarticulata* West & West, *Gloeotrichia* sp., and *Rivularia* sp. Vascular plants occur only at the margins of the two main streams.

FIGURE 6. The major drainage through the north part of the Swamp, showing the erratic course of the stream and the unstable substrate adjacent to it.

Several crustose lichens occurred on smooth, rounded boulders in the stream bed in the south-east part of the Swamp. These lichens, *Rhizocarpon disporum* (Naeg. ex Hepp) Müll. Arg., *Acarospora veronensis* Mass., *Lecanora melanophthalma* (Ram.) Ram., *Physcia caesia* (Hoffm.) Hampe, *Dimelaena oreina* (Ach.) Norm., and *Xanthoria elegans* (Link) Th.Fr., all grew at a level of more than 1 foot above maximum observed high-water.

(3) Banks. The bank habitat occurs in the south and south-east parts of the Swamp and at the Swamp–forest boundary on the south and west. Several inches of fibrous, organic rich soil of good drainage and good water-holding capacity, lying on the substrate above the seepage and flowing water, supports moist-habitat and mesic species of mosses, herbs, and shrubs.

The terricolous lichens, *Peltigera aphthosa* (L.) Willd., *Cladina mitis* (Sandst.) Hale & W.Culb., *Cladonia cariosa* (Ach.) Spreng., *C. cenotea* (Ach.) Schaer., *C. chlorophaea* (Flörke ex Somm.) Spreng, sensu lato, *C. pyxidata* (L.) Hoffm., *Cetraria ericetorum* Opiz, *C. nivalis* (L.) Ach., and *Lecanora epibryon* (Ach.) Ach.; and the rotten-wood lichens, *Cladonia coniocraea* (Flörke) Spreng., *C. fimbriata* (L.) Fr., *C. gracilis* var. *dilatata* (Hoffm.) Schaer., *C. pocillum* (Ach.) O.Rich., *Hypogymnia austerodes* (Nyl.) Räs., *Parmelia sulcata* Tayl., and *Parmeliopsis ambigua* (Wulf.) Nyl. were found only in the bank habitat.

A series of lignicolous lichens were found on the dry, deeply-weathered roots of a windthrown *Picea glauca* (Moench) Voss in the bank habitat: *Lecidea glomerulosa* (DC.) Steud., *Lecanora coilocarpa* (Ach.) Nyl., *L. varia* (Ehrh.) Ach., *Candelaria concolor* (Dicks.) B.Stein, *Cetraria pinastri* (Scop.) S. Gray, *Parmelia elegantula* (Zahlbr.) Szat., *P. exasperatula* Nyl., *Parmeliopsis hyperopta* (Ach.) Arn., *Letharia vulpina* (L.) Hue, *Usnea glabrescens* (Nyl. ex Vain.) Vain., *U. substerilis* Mot., *Physcia caesia* (Hoffm.) Hampe, *Caloplaca holocarpa* (Hoffm.) Wade, and *Lepraria membranacea* (Dicks.) Vain.

The mosses of the bank habitat are *Tortella fragilis* (Hook. ex. Drumm.) Limpr., *T. tortuosa* (Hedw.) Limpr., *Tortula ruralis* (Hedw.) Gaertn., Meyer & Scherb., *Funaria hygrometrica* Hedw., *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer

& Scherb., *B. stenotrichum* C. Müll., *Leptobryum pyriforme* (Hedw.) Wils., *Amblyodon dealbatus* (Hedw.) B.S.G., *Meesea uliginosa* Hedw., *Campylium stellatum* (Hedw.) C.Jens., *Drepanocladus uncinatus* (Hedw.) Warnst., *Tomenthypnum nitens* (Hedw.) Loeske, *Pleurozium schreberi* (Brid.) Mitt., and *Hylocomium splendens* (Hedw.) B.S.G.

The vascular species of the banks are *Carex concinna* R.Br., *Lilium philadelphicum* (L.) var. *andinum* (Nutt.) Ker, *Smilacina stellata* (L.) Desf., *Corallorhiza trifida* Châtelain, *Cypripedium calceolus* L. var. *pubescens* (Willd.) Correll, *Habenaria obtusata* (Pursh) Richards., *H. unalascensis* (Spreng.) S.Wats., *Listera borealis* Morong, *Orchis rotundifolia* Banks, *Spiranthes romanzoffiana* Cham. & Schl., *Salix glauca* L., *S. pseudocordata* (Anderss.) Rydb., *Betula occidentalis* Hook., *Anemone multifida* Poir., *Amelanchier alnifolia* Nutt., *Rosa acicularis* Lindl., *Viola renifolia* A.Gray, *Zizia aptera* (A. Gray) Fern., *Cornus canadensis* L., *Pyrola asarifolia* Michx., *Androsace chamaejasme* Host, and *Campanula rotundifolia* L.

The following vascular plants grow in the saturated soil near water level, at the base of the banks: *Poa pratensis* L., *Carex garberi* Fern. var. *bifaria* Fern., *Eriophorum viridi-carinatum* (Engelm.) Fern., *Tofieldia pusilla* (Michx.) Pers., *Epilobium glandulosum* Lehm., *Dodecatheon radicatum* Greene, *Pinguicula vulgaris* L., and *Lobelia kalmii* L.

(4) Well-drained tufa. This habitat, the largest, comprises those central parts of the Swamp, between the two major streams, which are also in slight relief above the minor water courses formed by the coalescence of spring flow (Figure 2). It is characterized by scattered shrubs and coniferous trees, and sparse herbs on a loose, tufa pavement. The surface material is of generally sharp, gravel-sized fragments underlain by a mixture of lesser fragment sizes. Where this type occurs in the west part of the Swamp, generally above 4730 feet, it is subject to surface waterflow during June, decreasing to moist by early July. Although this type sometimes becomes quite warm on the surface during sunny days, it remains cool and moist beneath.

The flora of the well-drained tufa habitat includes generally mesophytic to somewhat xerophytic species of herbs and woody plants typical of the surrounding coniferous forests and open areas. A number of typically wet-habitat herbaceous species occur on the well-drained tufa in locations where there is surface waterflow during their period of activity, or where the substrate remains wet from copious seepage. Liverworts are absent from this habitat and the drought-resistant mosses occur as a trace.

The vascular plants of the well-drained tufa habitat vary in abundance from the locally common *Geocaulon lividum* (Richards.) Fern. to the single frondlike stem of *Lonicera dioica* L. var. *glaucescens* (Rydb.) Butters. The following vascular plants were found in the dry parts of the well-drained tufa habitat: *Juniperus communis* L., *J. horizontalis* Moench, *Picea glauca* (Moench) Voss var. *albertiana* (S.Brown) Sarg., *Pinus contorta* Loudon var. *latifolia* Engelm., *Agropyron trachycaulum* (Link) Malte, *Danthonia intermedia* Vasey, *Deschampsia caespitosa* (L.) Beauv., *Elymus innovatus* Beal, *Carex eburnea* Boott, *Zygadenus elegans* Pursh, *Habenaria hyperborea* (L.) R.Br., *Salix glauca* L., *Betula glandulosa* Michx., *Anemone parviflora* Michx., *Ranunculus occidentalis* Nutt., *Parnassia montanensis* Fern. & Rydb., *Fragaria virginiana* Duchesne, *Potentilla fruticosa* L., *Shepherdia canadensis* (L.) Nutt., *Epilobium angustifolium* L., *Zizia aptera* (A.Gray) Fern., *Arctostaphylos rubra* (Rehd. & Wils.) Fern., *A. uva-ursi* (L.) Spreng., *Ledum groenlandicum* Oeder, *Gentiana affinis* Griseb., *Gentianella amarella* (L.) Börner ssp. *acuta* (Michx.) J.M.Gillet, *Castilleja miniata* Dougl., *Galium boreale* L., *Linnaea borealis* L. var. *americana* (Forbes) Rehd., *Campanula rotundifolia* L., *Antennaria pulcherrima* (Hook.) Greene, *Crepis runcinata* (James) T.&G., *Senecio pauperculus* Michx., and *Solidago decumbens* Greene.

Agrostis alba L., *Calamagrostis inexpansa* A.Gray, *Phleum pratense* L., *Poa annua* L., *Tofieldia glutinosa* (Michx.) Pers., *Saxifraga aizoides* L., *Dodecatheon radicatum* Greene, *Prunella vulgaris* L., *Lobelia kalmii* L., *Aster ciliolatus* Lindl., and *A. eatonii* (A.Gray) Howell all grow on the well-drained tufa in microhabitats having early-season surface waterflow or seepage through the tufa, which remains available to the plants until midsummer.

Only two lichens, *Letharia vulpina* (L.) Hue and *Usnea substerilis* Mot., both from a dead tree, were collected in the well-drained tufa habitat.

Faunal Occurrence

Middle Springs Swamp is inhospitable to small mammals. In 215 trap nights, from June 14 to July 31, 1970, in the Swamp and in the bordering forest, Routledge (1970) made five captures. The captures within the Swamp were both shrews, one near a stream, the other in the well-drained tufa habitat.

Mule deer are occasionally seen feeding on low plants in the well-drained tufa habitat. The tracks of moose seem to be those of animals on the move. There is very little evidence of browsing in the Swamp, in which most of the shrubs are the unpalatable *Potentilla fruticosa* L., with only a small amount of *Betula glandulosa* Michx. The very small amount of breakage of the three clusters of *Betula occidentalis* Hook. on the west boundary of the Swamp is probably from browsing by moose.

There seems to be very little of interest in the Swamp for most birds, and their visits from the surrounding forest appear to be of a casual nature. The Downy Woodpecker and the Black-capped Chickadees, seen occasionally, were there to investigate the insect possibilities of the scattered, unthrifty *Picea glauca* (Moench) Voss and *Pinus contorta* Loudon. A pair of Common Snipe were flushed several times from patches of shaded, cool, moist, dense sedge-grass-herbs beside the swiftly flowing stream in the north part of the Swamp.

Discussion

The seasonal and annual fluctuation of water in Middle Springs Swamp is a severe environment hazard to some plants. The perennial vascular plants present are those either adapted to specific conditions or having a wide tolerance. The bryophytes occur generally where suitable moisture is relatively constant. From October 1969 through March 1970 the precipitation, measured at Banff townsite, was two-thirds that of the corresponding period of the previous winter (Anonymous 1971). Seepage flow through the Swamp during the "high-water" period of 1970 was less than the minimum August flow of 1969. The Swamp remained dry throughout the growing season, and herbaceous productivity was greatly reduced. Seepages along the west boundary of the Swamp, which in 1969 had supported a dense tangle of *Cardamine pensylvanica* Muhl. about 18 inches high had, during the following year, a patchy cover less than 8 inches high. The aquatic bryophytes growing in the minor spring-coalescence water courses were severely checked by this drought.

The lichen flora of the Swamp is restricted almost entirely to a sparse occurrence of corticolous, lignicolous, and saxicolous forms. The terricolous lichens are represented by a few poorly formed individuals of a few species.

A total of 193 species of plants are recorded from Middle Springs Swamp: 22 algae, 11 liverworts, 22 mosses, 35 lichens, and 103 vascular plants. Notable among the vascular plants are the large number of sedges (12 species) and orchids (eight species).

Approximately 60 species of the vascular plants in the Swamp are typically wet-habitat or marsh species, many of which are of relatively infrequent occurrence in this region, compared with those of typically upland occurrence which are common and widely distributed.

The unusual geology of Middle Springs Swamp, with its attendant flora, warrants the preservation of this area from human disturbance. The Swamp has an intimate interdigitation of mineral springs, seepages, seasonal surface waterflows, restricted drainage, small rapidly-flowing streams, wet marl-and-organic deposits, moist fibrous organic soils, and freely drained wet-to-dry deposits of friable tufa, each of which has its distinctive plant association, with a range of cover on the substrates from complete, in the wet-to-moist situations, to sparse on the dry tufa.

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The Status of Birds at Selected Sites in Northern Ontario

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Abstract. Lists of birds found, and available breeding data, are given for six localities in northern Ontario (Cochrane, Moosonee, Fort Albany, Attawapiskat, Hawley Lake, and Winisk) and compared quantitatively with similar lists from adjacent areas.

Introduction

On several recent occasions we have been in northern Ontario, and this has given us opportunity to survey the status of birds in that region. The general paucity of such information justifies this presentation.

Most of our observations are from the vicinity of the settlements of Cochrane, Moosonee, and Fort Albany, Cochrane District, and Winisk, Kenora District, and from several camps: 14 miles SSE Cochrane, 11–20 August 1972 (FWS, JDR, Donald K. Riker, Robert Rybczynski); Whitetop Creek (WTC), 12 mi NE of Moosonee, 11–14 June 1971 (JDR, FWS, James A. Dick), 1–3 June 1972 (FWS, Paul W. Schueler); 6 mi NE of Attawapiskat, Kenora District (Atwpskt), 15–22 June 1971 (JDR, FWS); 4 mi E of Winisk, 23–28 June 1971, (JDR, FWS); Winisk River, 20 mi from Winisk, at latitude 55°, 16–17 June 1965 (DHB); Hawley Lake (HL), 60 mi SSE of Winisk, 14–16 June and 1–5 July 1962 (DBH and D. J. T. Hussell), 10–27 June, 29 June – 5 July, 13–21 July 1964 (DHB), 9–19 July 1965 (DHB); southern end of Sutton Lake, 30 mi S of Hawley Lake, 27–29 June 1964 (DHB); Aquatuk Lake, 70 mi SSE of Winisk, 5–13, 21 July 1964 (DHB). FWS, JDR, D. K. Riker, and R. Rybczynski were in the vicinity of Cochrane 11–20 August 1972; most observations made there are from our camp (14 mi SSE of Cochrane), 3 mi N of Cochrane (S of Genier), and the vicinity of Fraserdale. JDR, D. K. Riker, and Kenneth Huebner spent 4 July 1973, 10 mi N of Smooth Rock Falls, near Cochrane.

JDR and FWS were in Moosonee on 10 and 14 June and 6 July 1971, FWS and P. W. Schueler were there 26-31 May and 3–5 June 1972. DHB was at Fort Albany 27 August – 9 September 1964. DHB was in Winisk and vicinity 22 June 1964 and 3 June – 8 July 1965. JDR and FWS were there 29 June – 5 July 1971. DHB and D. J. T. Hussell canoed down the Sutton River from HL to Hudson Bay and back, 16 June – 1 July 1962. Brief accounts of the vegetation surrounding each of the 1971 localities are given in Schueler (1973).

Specimens taken are deposited in the research collection at the Royal Ontario Museum, Toronto, and numbers in the text are the catalogue numbers of that institution. Data on distribution and relative abundance are summarized in Table 1; when available, additional interesting information, especially that pertaining to nesting, is given in the Species Accounts. The nomenclature used, both binominal and English, follows the American Ornithologists' Union Check-list (1957).

Species Accounts

COMMON LOON. *Gavia immer*. A female (93,051), 30 June 1962, HL, had eggs in her oviduct.

CANADA GOOSE. *Branta canadensis*. We noted fledged young 22 June 1962 along the Sutton River, 30 mi NE of HL, and took two (92,970; 92,973). We found a pair with three downy young 10 July 1964, HL.

MALLARD. *Anas platyrhynchos*. A female (110,003) taken 12 June 1971, WTC, had three ruptured follicles, one shelled egg in oviduct, and four enlarged ova; Mallards were common in marshes there. A possible male Mallard × Black Duck hybrid was seen 31 May 1972, 2 mi N of Moosonee.

BLACK DUCK. *Anas rubripes*. Pairs with 3-week-old young were found 9 July 1964 and 12 July 1964, Aquatuk Lake.

PINTAIL. *Anas acuta*. A female (95,071) and eight ¼-incubated eggs were found 9 June 1965, Winisk; a female with ¼-grown young was seen 23 June 1971, 4 mi E of Winisk.

TABLE 1 — Birds recorded at Moosonee (Msone), Fort Albany (Ft. Alb.), Attawapiskat (Atwpskt), Winisk (Wnsk), Cochrane (Coch), and Hawley Lake (HL), Ontario. x = present, status not determined; 0 = not recorded; 1 = uncommon; 2 = common, in suitable habitat; 3 = abundant. * indicates that we found evidence of nesting. Italics indicate specimen(s) taken. 62 = 1962; SR = Sutton River; FR = Fraserdale.

Species	Msone	Ft. Alb.	Atwpskt	Wnsk (65)	Wnsk (71)	HL (64)	HL (65)	Coch
Common Loon	x	0	x	2	x	2	_2,62*_	0
Arctic Loon	0	0	0	x	0	0	0	0
Red-throated Loon	0	0	0	_1_	0	0	0	0
Great Blue Heron	0	0	0	0	0	0	0	xFR
American Bittern	3–2	2	_2_	1	1	x	1	x
Canada Goose	_x_	_2_	x	x	x	1*	_62*_	0
Snow Goose	0	2	x	x	0	0	0	0
Mallard	_2_	_2_	2	2	2	2*	1	0
Black Duck	2	_2_	1	2	1	2*	_2*_	x
Pintail	2	_1_	2	_2*_	2*	0	0	0
Green-winged Teal	2	_2_	1	_2_	1	1*	1*(62SR)	0
Blue-winged Teal	1	_1_	1	0	1	0	0	0
American Widgeon	2	0	2	2	_1*_	_1*_	_2_	0
Shoveler	0	_1_	0	0	1	0	0	0
Wood Duck	0	0	0	0	0	0	0	x
Ring-necked Duck	0	0	0	0	0	0	0	x
Lesser Scaup	0	0	0	1	0	2	0	0
Scaup sp.	x	0	0	x	0	x	1	0
Common Goldeneye	1	_2_	0	2	2	x	2	x
Bufflehead	0	1	0	_1_	0	0	0	0
Oldsquaw	x	0	0	0	0	0	0	0
White-winged Scoter	0	0	0	1	0	x	0	0
Surf Scoter	0	0	0	1	0	_1_	2	0
Common Scoter	x	0	0	1	0	x	0	0
Common Merganser	1	0	x	1	x	3	2	0
Red-breasted Merganser	1	0	0	x	0	_2_	_x_	0
Goshawk	0	0	0	0	0	x*	0	0
Red-tailed Hawk	0	0	0	0	0	1	x	0
Broad-winged Hawk	0	0	0	0	0	0	0	2
Rough-legged Hawk	x	0	x	x	x	0	0	0
Golden Eagle	0	0	0	0	0	x	0	0
Bald Eagle	0	0	0	0	0	x	0	0
Marsh Hawk	2	2	1	1	0	x	0	x
Osprey	x	0	x	x	x	1*	x	0
Pigeon Hawk	0	0	0	_x_	1	x*	x	0
Sparrow Hawk	0	0	0	0	0	x	1	2
Spruce Grouse	0	0	0	0	0	_1*_	_62_	x*
Ruffed Grouse	x	0	0	0	0	0	x	_2*_
Willow Ptarmigan	0	0	0	1	x	_x_	_62*SR_	0
Sandhill Crane	1	0	0	0	0	0	0	0
Sora	_2_	0	0	0	0	0	0	0
Yellow Rail	2	0	_2*_	x	_2_	0	0	0
Common Gallinule	0	0	0	x	0	0	0	0
Semipalmated Plover	0	0	0	_1*_	1	_x_	_62*SR_	0
Killdeer	_2_	0	2*	1*	1	0	0	x
Black-bellied Plover	2	0	x	x	x	0	0	0
Ruddy Turnstone	x	0	0	x	0	0	0	0
Common Snipe	_2_	2	_2_	2	_2_	1	1	_2_
Whimbrel	0	2	0	1	1	0	_62*SR_	0
Spotted Sandpiper	2	0	2	_2*_	2	_3*_	_2,62*_	x
Solitary Sandpiper	x	0	0	0	0	_1*_	_1_	x
Greater Yellowlegs	x	_2_	x	1*	x	_2*_	_x_	0
Lesser Yellowlegs	0	2	0	_1*_	0	_2*_	_x_	0
Knot	x	0	0	0	0	0	_62*SR_	0
Pectoral Sandpiper	0	0	0	0	0	0	0	x

TABLE 1 — (*Continued*)

Species	Msone	Ft. Alb.	Atwpskt	Wnsk (65)	Wnsk (71)	HL (64)	HL (65)	Coch
Least Sandpiper	0	0	0	_1*_	0	0	_62*_	0
Dunlin	0	0	_x_	_1*_	0	x	_62*SR_	0
Short-billed Dowitcher	0	0	0	_x_	0	_x_	_62_	0
Dowitcher sp.	0	0	0	x	0	0	0	0
Stilt Sandpiper	0	0	0	0	0	0	_62*SR_	0
Semipalmated Sandpiper	0	0	0	_1*_	1	0	_62*SR_	0
Hudsonian Godwit	0	_2_	0	_2_	0	_x_	_62SR_	0
Northern Phalarope	0	0	0	_x_	0	0	_62*SR_	0
Parasitic Jaeger	x	0	0	0	0	0	0	0
Long-tailed Jaeger	0	0	0	x	0	0	0	0
Herring Gull	2	0	2	_2*_	2	1	_2,62*_	0
Ring-billed Gull	1	0	0	0	1	0	0	0
Bonaparte's Gull	0	0	0	2	x	_2*_	_2_	x
Common Tern	0	0	0	0	0	_x_	0	0
Arctic Tern	x	0	0	_1*_	0	0	_62*SR_	0
Tern (*Sterna*) sp.	x	1	x	0	x	x	0	0
Caspian Tern	0	2	0	0	0	0	0	0
Black Tern	0	1	0	0	0	0	0	0
Black Guillemot	0	0	0	0	0	0	x	0
Rock Dove	0	0	0	0	0	0	0	1
Great Horned Owl	0	0	0	0	0	x	_62_	1
Hawk Owl	0	0	0	0	0	0	_62*_	0
Short-eared Owl	0	1	0	1	2	0	0	0
Common Nighthawk	1	0	0	x	0	_2_	1	2
Belted Kingfisher	2	0	0	2*	0	2	_2,62*_	1
Yellow-shafted Flicker	_1*_	0	1	1	0	_2*_	_2*_	1
Yellow-bellied Sapsucker	0	0	x	0	0	0	0	_1FR_
Hairy Woodpecker	0	0	0	0	0	0	_1*_	1
Black-backed Three-toed Woodpecker	0	0	0	0	0	_1*_	_62_	xFR
Northern Three-toed Woodpecker	0	0	0	0	0	1	0	0
Eastern Kingbird	_x_	0	0	_x_	0	0	0	_2*_
Yellow-bellied Flycatcher	0	0	0	1	0	_1_	0	0
Traill's Flycatcher	_2_	0	_2_	0	_1_	0	0	_2_
Least Flycatcher	_2_	0	_2_	0	0	0	0	_2_
Olive-sided Flycatcher	0	0	0	0	0	_1_	_1_	0
Horned Lark	x	0	0	_1*_	_1*_	0	0	0
Tree Swallow	_2_	1	2	_2_	_2_	_2*_	2	x*
Bank Swallow	1*	1	0	0	0	0	0	0
Barn Swallow	1	0	0	0	0	0	0	x
Cliff Swallow	0	0	0	0	0	0	0	2FR*
Gray Jay	_2*_	0	1	_1*_	_2*_	_2*_	_2*_	_2*_
Blue Jay	0	0	0	0	0	0	0	1,1FR
Common Raven	2	0	2	2*	2*	_1*_	x	2
Common Crow	2	1	2	2	2	x	0	2
Black-capped Chickadee	x	0	1	0	0	0	0	_1_
Boreal Chickadee	_1_	0	1	1	1	_x_	1	_1_
Red-breasted Nuthatch	0	0	0	0	0	0	0	x
Brown Creeper	0	0	0	1	0	0	0	x
Winter Wren	0	0	0	0	0	0	0	_x_
Robin	_2*_	0	2	_2*_	1*	2*	_2_	_2*_
Hermit Thrush	1	0	0	0	0	_1*_	_62_	_2_
Swainson's Thrush	_2_	0	_2_	0	_1*_	_1*_	_2_	_2*_
Gray-cheeked Thrush	0	0	0	1	_1_	_2*_	_2*_	0
Golden-crowned Kinglet	_1_	0	0	0	0	0	0	x
Ruby-crowned Kinglet	_2*_	0	1	1	1	_1_	_62_	2
Bohemian Waxwing	0	0	0	0	0	_1*_	1	0
Cedar Waxwing	x	0	x	0	x	_1*_	0	x

TABLE 1 — (*Continued*)

Species	Msone	Ft. Alb.	Atwpskt	Wnsk (65)	Wnsk (71)	HL (64)	HL (65)	Coch
Northern Shrike	1*	0	0	0	1	0	0	0
Starling	2	0	0	x	x*	x	0	2*
Red-eyed Vireo	2	0	0	0	0	0	0	2
Philadelphia Vireo	2*	0	1	0	0	0	0	2
Black-and-white Warbler	2	0	1	0	0	0	0	x
Tennessee Warbler	2	0	3*	1	3	2	62	x
Orange-crowned Warbler	0	0	0	2	1	x	1	x
Yellow Warbler	3*	0	3*	3*	2	1	0	x
Magnolia Warbler	0	0	0	0	0	0	0	2
Myrtle Warbler	1	0	0	1	1	2*	1,62*	2FR
Chestnut-sided Warbler	0	0	0	0	0	0	0	2
Blackpoll Warbler	0	0	1	3*	3*	2*	2	0
Palm Warbler	0	0	0	0	0	0	x	0
Ovenbird	1	0	0	0	0	0	0	1
Northern Waterthrush	2	0	2	1	1	1*	2*	0
Mourning Warbler	1	0	1	0	0	0	0	x
Yellowthroat	1	0	0	0	0	0	0	2
Wilson's Warbler	2	0	1	3	1	1*	2	1
Canada Warbler	x	0	0	0	0	0	0	x
American Redstart	1	0	0	0	0	0	0	x
House Sparrow	0	0	0	0	0	0	0	2
Bobolink	0	0	0	0	0	0	0	1
Eastern Meadowlark	0	0	1	0	0	0	0	0
Red-winged Blackbird	2	0	1	1	0	0	0	2
Rusty Blackbird	0	2	0	x	1	2*	2*	1
Common Grackle	1-2	1	0	x64	0	0	0	1
Brown-headed Cowbird	1	0	1	1	0	0	0	1
Evening Grosbeak	x	0	0	0	0	0	0	x
Purple Finch	x	0	0	0	0	0	0	0
Pine Grosbeak	0	0	0	0	0	x	0	0
Common Redpoll	0	0	0	2	3*	0	0	0
Pine Siskin	0	0	0	0	0	0	0	x
American Goldfinch	x	0	0	0	0	0	0	2
Crossbill sp.	0	0	x	0	0	0	0	x
Savannah Sparrow	3*	2	3*	3	3*	x	62*SR	3*
LeConte's Sparrow	2	0	2*	0	1	0	0	x
Sharp-tailed Sparrow	2	1	2	x	2	0	62*SR	0
Slate-colored Junco	1	0	0	1	1	3*	2	2
Tree Sparrow	0	0	0	2	3*	0	0	0
Chipping Sparrow	2	0	0	0	0	x	0	2
Clay-colored Sparrow	0	0	1	0	0	0	0	0
White-crowned Sparrow	1	0	1	2*	2*	3*	2	0
White-throated Sparrow	3*	0	2*	3	2*	3*	2	3*
Fox Sparrow	1	0	2*	3	2*	1*	x	0
Lincoln's Sparrow	2*	0	1	2*	1*	1*	2*,62*SR	2
Swamp Sparrow	2	1	2*	0	2	1	62*	1*
Song Sparrow	2	0	2*	1	2	0	0	1
Lapland Longspur	x	0	0	x	0	0	0	0
Smith's Longspur	0	0	0	3*	2*	0	62SR	0
Snow Bunting	0	0	0	x	0	0	0	0

BLUE-WINGED TEAL. *Anas discors*. DHB took a flightless juvenile (97,581) from a brood at Kinoje River near Ft. Albany, 31 Aug. 1964, and we saw at least two pairs Atwpskt, one pair 4 mi E of Winisk (1971) and one individual 2 June 1972, WTC. Previous accounts indicated that these ducks were uncommon in northern Ontario (Manning 1952) and our observations suggest that this species is extending its range in this region.

AMERICAN WIDGEON. *Mareca americana*. A newly hatched chick (110,596) was found dead 1 July 1971, Winisk, and two downy young (94,499; 94,500) were taken 16 July 1964, HL.

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AMERICAN WIDGEON. *Mareca americana*. A newly hatched chick (110,596) was found dead 1 July 1971, Winisk, and two downy young (94,499; 94,500) were taken 16 July 1964, HL.

SHOVELER. *Spatula clypeata*. We saw two males 23 and 28 June 1971, 4 mi E of Winisk. Shovelers have not previously been recorded in Ontario north of Attawapiskat (Manning 1952).

WOOD DUCK. *Aix sponsa*. Robert Rybczynski saw four, 19 Aug. 1972, 2 mi W of Clute, Cochrane District.

GOSHAWK. *Accipiter gentilis*. A nest 35′ in a *Populus*, 12 June 1964, was found near Aquatuk Lake, one young visible from the ground. DHB photographed this nest.

OSPREY. *Pandion haliaetus*. We saw one juvenile with two adults, 5 July 1964, Aquatuk Lake. Joseph Chockomolin (personal communication) found Ospreys nesting near the confluence of the Warchesku and Sutton Rivers in 1962, and saw an adult there in June of that year.

PIGEON HAWK. *Falco columbarius*. A female (95,076), 6 June 1965, Winisk, from a pair, had enlarged ova; a pair seen 26 June 1971, Winisk, and a female, 12 July 1964, Aquatuk Lake, were territorial.

SPRUCE GROUSE. *Canachites canadensis*. A female (94,501), 9 July 1964, Aquatuk Lake, was accompanied by flying "robin-sized" young. A female with flightless young was seen 4 July 1973, 10 mi N of Smooth Rock Falls.

RUFFED GROUSE. *Bonasa umbellus*. We took a nearly grown juvenile (115,209) 3 mi N of Cochrane, 16 Aug. 1972.

WILLOW PTARMIGAN. *Lagopus lagopus*. We took a pair (92,979; 92,980) 21 June 1962, 54 mi NE of HL, along the Sutton River. The female (92,980) had an egg in her oviduct and an incubation patch.

SANDHILL CRANE. *Grus canadensis*. FWS and J. A. Dick saw a pair 13 June 1971, at a marsh inland from the WTC camp. FWS and P. W. Schueler saw a single bird foraging 31 May 1972 on the mudflats N of Shipsands Is., near WTC, and 3 June 1972, flying N of WTC.

SORA. *Porzana carolina*. A male (110,033) collected 14 June 1971, WTC, was in breeding condition (left testis 15 × 5 mm). Soras seem to be common there, as many were calling in 1972.

YELLOW RAIL. *Coturnicops noveboracensis*. These rails were apparently common in sedge-grass marshes at all coastal stations. Two specimens taken 15 June, Atwpskt, were a laying female (110,626) with four ruptured follicles and shelled egg in oviduct, and a male (110,627) (left testis 17 × 9 mm); one (110,567), taken 27 June 1971, 4 mi E of Winisk, is preserved in alcohol. An abandoned nest, containing at least six eggs, was found 20 June in sedge-grass marsh at Atwpskt.

SEMIPALMATED PLOVER. *Charadrius semipalmatus*. Three nests were found: Sutton River at the tree line, 23 June 1962, four well incubated eggs; N end of HL, 5 July 1962, one of four eggs hatching; island in Winisk River 20 mi from Winisk, 16 June 1965, two eggs, yolks clear.

KILLDEER. *Charadrius vociferus*. Two nests were found, both with four eggs: 18 June, Atwpskt; 3 July 1965, Winisk.

COMMON SNIPE. *Capella gallinago*. A nest in wet tamarack swamp, 54 mi N of HL, 21 June 1962, contained four eggs.

SPOTTED SANDPIPER. *Actitis macularia*. A female (94,569) taken 11 June 1964, HL, was about to lay. Six nests each contained four eggs which were being incubated: Sutton River, 38 mi N of HL, 18 June 1962; confluence of Sutton and Aquatuk Rivers, 20 June 1962; W side of HL, 30 June and 3 July 1962; N end of HL, 5 July 1962; HL, 20 June 1964; HL, 20 and 21 June 1964. Another nest at HL contained four eggs from 17 June – 3 July 1964, and was empty on 14 July. All nests were on the ground among spruces or willows.

SOLITARY SANDPIPER. *Tringa solitaria*. Males (92,988; 92,989) taken 29 June 1962, 10 mi NE of HL, and 22 June 1962, 54 mi NE of HL, had enlarged testes. A nest 6.5′ up in a 15′ spruce tree, S end of Sutton Lake, 28 June 1964, contained four eggs with 15-mm embryos with eyes formed; a juvenile (94,569) was taken from the N end of HL, 16 July 1964.

GREATER YELLOWLEGS. *Totanus melanoleucus*. A female (94,540), taken 17 June 1964, N end of HL, had enlarged ova. We saw apparently territorial pairs 17 June 1965, S of Winisk.

LESSER YELLOWLEGS. *Totanus flavipes*. Females (92,985; 94,571), shot 14 June 1962 and 12 June 1964, HL, had enlarged ovaries. We saw apparently territorial pairs S of Winisk 17 June 1965.

KNOT. *Calidris canutus*. A male (92,993), with large testes, and a female (92,994), with an enlarged ovary and one unshelled ovum in her oviduct, were taken from a small flock, 23 June 1962, at the limit of trees along the Sutton River.

LEAST SANDPIPER. *Erolia minutilla*. A female (92,996) with enlarged ova, was taken 16 June 1962, 20 mi NE of HL along the Sutton River, and a nest containing four eggs was found 22 June 1962, 54 mi NE of HL along the Sutton River.

DUNLIN. *Erolia alpina*. A nest with two eggs was found 24 June 1962, at the mouth of the Sutton River, and another nest containing downy young was found there that day. A female (95,089), 11 June 1965, Winisk, had enlarging ova; two (95,091; other not saved) taken there 25 June 1965 were laying.

STILT SANDPIPER. *Micropalama himantopus*. A downy young (92,998) was taken 24 June 1962, from a brood of four, at the mouth of the Sutton River.

SEMIPALMATED SANDPIPER. *Ereunetes pusillus*. Two nests were found containing four eggs: one was 4/5-incubated, 24 June

1962, at the mouth of the Sutton River (an adult flushed off the nest is 92,995); the other was 1/3-incubated, 25 June 1965, 20 mi E of Winisk.

NORTHERN PHALAROPE. *Lobipes lobatus*. Two females (92,999; 93,000) in breeding condition were taken 24 June 1962, at the mouth of the Sutton River; the latter contained a shelled egg in her oviduct.

HERRING GULL. *Larus argentatus*. Five nests were found: one contained 3 half-incubated eggs, 23 June 1962, on a small island in the Sutton River near HL; one had one egg, and two had two pipped eggs each, on an island in the Winisk River, 20 mi from Winisk, 16–17 June 1965; one contained one egg, yolk clear, on an island in the Winisk River, 14 mi from Winisk.

RING-BILLED GULL. *Larus delawarensis*. We saw one at WTC in 1971 and several were in the Moosonee area in 1972, and two were seen 4 mi E of Winisk, in 1971.

BONAPARTE'S GULL. *Larus philadelphia*. Common at HL. A female (94,573), 12 June 1964, HL, had an unshelled egg in her oviduct.

ARCTIC TERN. *Sterna paradisaea*. A nest with two well-incubated eggs was found 23 June 1962 at the limit of trees, along the Sutton River. Three nests with one egg each and three with two eggs each were found on an island in the Winisk River, 20 mi from Winisk, 16–17 June 1965.

HAWK OWL. *Surnia ulula*. A male (93,007) of a pair was taken 16 June 1962, 8 mi NE of HL, along the Sutton River at its confluence with the Warchesku River.

BELTED KINGFISHER. *Megaceryle alcyon*. A nest containing seven eggs was found 17 June 1962 along the Sutton River, 20 mi NE of HL. The species is fairly common along the Sutton, Moose, and Winisk Rivers, and individuals were seen entering nesting holes 17 June 1965 along the last.

YELLOW-SHAFTED FLICKER. *Colaptes auratus*. A female (114,136), 4 June 1972, from a *Populus balsamifera* stand along the Moose River N of Moosonee, had five ruptured follicles and three enlarged ova. A nest with seven eggs was found 15 June 1962, 5′ up in a burned spruce, Sutton Gorge. Four young in a nest 4′ up in a burned spruce, N end of HL, were naked and blind, with egg shells in the nest, on 17 June 1964; two of these (94,510; 94,511) collected 1 July had primaries 3/4-sheathed. Adults were visiting a nest in a dead spruce from 9–15 July 1965, HL.

YELLOW-BELLIED SAPSUCKER. *Sphyrapicus varius*. We found the characteristic drillings of this species on the side of a spruce tree at Atwpskt, suggesting possible low density occupancy there, north of the previously delimited range.

HAIRY WOODPECKER. *Dendrocopos villosus*. Four seen (two juveniles taken: 95,095; 95,096) 13 July 1965, HL, appeared to be a family group. This is the northernmost record for Ontario.

BLACK-BACKED THREE-TOED WOODPECKER. *Picoides arcticus*. Two specimens (93,009; 93,010) taken 15 June 1962, HL, appeared to be a pair, and the male had enlarged testes. A nest found 11 July 1964, Aquatuk Lake, contained two nearly fledged young and an infertile egg, and another nest found 28 June 1964, Sutton Lake, contained young.

TRAILL'S FLYCATCHER. *Empidonax traillii*. The birds we found were of the "fee-bee-o" song-type (i.e., *E. traillii, sensu* Stein (1963)). Breeding had apparently not yet commenced 11–14 June 1971, WTC, as two males (110,021; 110,044) collected there lacked protruding cloacae; females (114,117; 114,148) taken there in 1972 had not yet begun to lay. Two other specimens (110,502; 110,503), 21 June, Atwpskt, were males with protruding cloacae.

LEAST FLYCATCHER. *Empidonax minimus*. Specimens taken at WTC in 1971 indicate that nesting had commenced: of two females, one (110,022) had ruptured follicles and two enlarged ova, and the other (110,023) had enlarging ova (7 and 3 mm).

OLIVE-SIDED FLYCATCHER. *Nuttallornis borealis*. Males (93,011; 94,564) with enlarged testes were taken 25 June 1962, 41 mi NE of HL and 28 June 1964, Sutton Lake.

HORNED LARK. *Eremophila alpestris*. A female (110,579), 27 June 1971, 4 mi E of Winisk, was laying, and had two ruptured follicles (one egg in oviduct) and two other large follicles. Females (95,099; 95,100) with active brood patches were taken at Winisk, 24 and 25 June 1965, and a fledgling (95,098) was taken there 5 July 1965.

BANK SWALLOW. *Riparia riparia*. We found 11 active nest holes in the bank of the Moose River at Moosonee, 4 June 1972.

CLIFF SWALLOW. *Petrochelidon pyrrhonota*. These were found nesting on the Moosonee Lodge, Moosonee, in mid-June 1965, and were seen along the Ontario Northland Railway route, near dwellings, north to Fraserdale in both 1971 and 1972, and 11 pairs nested at Moosonee in 1972.

GRAY JAY. *Perisoreus canadensis*. Adults were usually seen in pairs, often accompanied by juveniles. Although this species ". . . lays ordinarily three or four eggs . . ." (Bent 1946, p. 5), each of the 14 family groups seen by us contained only two juveniles (although four birds seen 22 June 1971, Winisk, may have been a sibling group). In August 1972 we saw four pairs in the Cochrane area, one of which was accompanied by a dark-plumaged juvenile.

RAVEN. *Corvus corax*. A flightless immature male (94,557) was taken 29 June 1964, Sutton Lake. Winisk RCAF Base personnel caught four fledglings in June 1965. We saw a juvenile sitting on an island 28 June 1971, in the Winisk River at Winisk.

ROBIN. *Turdus migratorius*. Three nests were found in 1964 in second-growth spruce, near HL: 3′ in a small spruce, three eggs 23 June – 3 July, nest empty 16 July; 5′ in a 10-foot spruce, four eggs 1 July, three eggs and one dead young 3 July, nest destroyed before 16 July; four eggs 13 July, three young with primaries emerging 14 July. A nest at Winisk contained two 3/4-incubated and one infertile eggs, 29 June 1965; one 2.5′ in a small alder, WTC, 13 June 1971, contained three eggs, and another 12′ in a *Populus balsamifera*, Moosonee, 7 July 1971, contained three eggs. A female with four ruptured follicles, 28 May 1972, and another with an active brood patch, 30 May 1972, were taken at the Moosonee airstrip.

HERMIT THRUSH. *Hylocichla guttata.* A female (94,526) with brood patch was taken 16 July 1964, HL.

SWAINSON'S THRUSH. *Hylocichla ustulata.* A nest found 3.5′ in a willow, 5 July 1971, Winisk, contained three eggs; examination of the female's (110,604) ovary indicated that the clutch was complete. A juvenile male (94,524) was taken 16 July 1964, HL.

GRAY-CHEEKED THRUSH. *Hylocichla minima.* A female (94,523), 25 June 1964, HL, had an active brood patch, and a nest with three young was found 6 July 1964, Aquatuk Lake.

BOHEMIAN WAXWING. *Bombycilla garrulus.* This species is fairly common near the junction of the Sutton and Warchesku Rivers in 1962, 1964, and 1965. A female (94,528) taken there 19 July 1964, with a brood patch, is the first breeding record for Ontario.

CEDAR WAXWING. *Bombycilla cedrorum.* A female (94,530), 6 July 1964, Aquatuk Lake, had an enlarged ovary.

NORTHERN SHRIKE. *Lanius excubitor.* A female (113,648), 26 May 1972, Moosonee, had six ova enlarged to 2–4 mm; her stomach contained a White-throated Sparrow. One was seen at Winisk, 22 June 1971.

STARLING. *Sturnus vulgaris.* At Winisk these were fairly common near buildings in 1971. They have been there at least since 1965. A female (110,665), 25 June 1971, was feeding young. A dead juvenile (not saved) was found on the road 10 miles north of Smooth Rock Falls, 4 July 1973.

PHILADELPHIA VIREO. *Vireo philadelphicus.* We found these to be fairly common at Atwpskt in tall stands of *Populus balsamifera*; they have not previously been recorded north of the Albany River. A female taken 5 June 1972, Moosonee, had enlarged ova.

BLACK-AND-WHITE WARBLER. *Mniotilta varia.* We found these in low density at Atwpskt and Moosonee, and collected a male (110,470) with enlarged testes, 18 June 1971 at Atwpskt. They have not previously been reported north of the Albany River. A female (113,661), 28 May 1972, Moosonee, had one ovum slightly enlarged (2.5 mm).

TENNESSEE WARBLER. *Vermivora peregrina.* A female (110,497), 20 June, Atwpskt, had three ruptured follicles and two large (6 and 4 mm) ova. This warbler was common in open willow, and willow-alder thickets, and in spruce-willow bogs, at Atwpskt and Winisk. DHB collected breeding males (93,022; 94,531) 29 June 1962, 10 mi NE of HL, and 3 July 1964, HL.

YELLOW WARBLER. *Dendroica petechia.* Of eight females taken 11–14 June 1971, WTC, six had granular ovaries and two appeared ready to lay. One female, taken 5 June 1972, Moosonee, had a granular ovary. Two taken 21 June, Atwpskt, were laying: one (110,504) had two ruptured follicles, and two large ova; the other (110,505) was incubating. A nest found 18 June 1965, Winisk, was empty but contained two fresh eggs on 23 June.

MYRTLE WARBLER. *Dendroica coronata.* A nest containing three eggs was found 6′ high in a spruce 20 June 1962, HL, and DHB took laying females (93,026; 94,534) there, 3 June 1962 and 18 June 1964.

BLACKPOLL WARBLER. *Dendroica striata.* A female (94,538) with ova enlarged was taken 25 June 1964, HL; two females (110,589; 110,695), 1–2 July 1971, Winisk, had active brood patches. A nest among willows and aspen, 3 July 1965, Winisk, contained four eggs a few days from hatching; another 0.5′ in a 2′ spruce, HL, contained three eggs on 23 June 1964, four eggs 26 June – 3 July, and was empty on 14 July.

PALM WARBLER. *Dendroica palmarum.* An adult male (95,118) taken 17 July 1965, at junction of Warchesku and Sutton Rivers, is the northernmost record for this species in Ontario.

NORTHERN WATERTHRUSH. *Seiurus noveboracensis.* A mated female (94,561), 9 July 1964, Aquatuk Lake, had an active brood patch.

WILSON'S WARBLER. *Wilsonia pusilla.* A nest on the ground among willows, HL, contained five eggs on 1 and 3 July 1964, and was empty on 17 July.

HOUSE SPARROW. *Passer domesticus.* This species has been established in the Moosonee region since about 1911 (Manning 1952, p. 86), and DHB took three specimens (96,072–4) at Moosonee in Dec. 1965. We did not find it at Moosonee in the 1970s, suggesting that House Sparrows are intermittently present there.

EASTERN MEADOWLARK. *Sturnella magna.* About three singing birds were heard and seen 22 June 1971, at Attawapiskat village; Eastern Meadowlarks have not previously been recorded north of the Cochrane area, Cochrane District (Manning 1952; Smith 1957, p. 179).

RUSTY BLACKBIRD. *Euphagus carolinus.* A female (93,032) with enlarged ovary and brood patch was taken, 29 June 1962, HL, and a nest 2.5′ in *Salix*, with four naked young, was found 10 July 1964, Aquatuk Lake.

COMMON GRACKLE. *Quiscalus quiscula.* DHB saw a grackle 22 June 1964, Winisk, and three more at Fort Albany 9 September 1964. We saw several in Moosonee in 1971, and they were fairly common there in 1972.

EVENING GROSBEAK. *Hesperiphona vespertina.* DHB and R. Davis collected two (96,307–8) at the Moose Factory dump in Dec. 1965, and a male was seen singing in spruce woods 15 June 1971, Moosonee; this species has not previously been recorded this far north in Ontario (Manning 1952; Smith 1957, p. 180).

COMMON REDPOLL. *Acanthis flammea.* These were common in spruce-tamarack bogs in the Winisk region. A nest with five recently hatched young (eyes just open) was found 7 July 1965, Winisk; a female (110,689), 1 July 1971, Winisk, was laying (one ruptured follicle (shelled egg in oviduct), three large ova, and old ruptured follicles).

SAVANNAH SPARROW. *Passerculus sandwichensis.* Data on clutch-size and date of clutch completion for 1971 are summarized in Table 2.

LECONTE'S SPARROW. *Passerherbulus caudacutus.* Four males (109,973; 109,993; 109,999; 110,035), 11–14 June 1971, WTC, were all in breeding condition (testes and cloacae enlarged).

TABLE 2 — Data for breeding of Savannah Sparrows in northern Ontario, giving location, clutch size, and date when clutch was complete

	Clutch size[1]			Date clutch complete[2]		
Station	Number	Mean	Range	Number	Mean	Range
Moosonee (WTC)	11	4.0	4	26	14 June	6–20 June
Attawapiskat	29	4.1	4–5	39	17 June	6–25 June
Winisk	12	4.5	4–5	20	21 June	11–30 June

[1]Based on the numbers of eggs in nests found, and the numbers of ruptured and enlarged follicles in laying or recently post-laying female specimens examined.
[2]Estimated from the condition of ovaries of female specimens examined, the degree of incubation of eggs in nests found, and the size of young in nests.

Three females from Atwpskt were breeding: 110,629, 15 June, had two ruptured follicles and two enlarged ova; 110,630, 15 June, had three ruptured follicles, and one large ovum; 110,655, 20 June, was incubating. Of four females taken, WTC in 1972, only one (114,149), 5 June, had enlarged ova.

SHARP-TAILED SPARROW. *Ammospiza caudacuta*. None of the three females (110,428; 110,486; 110,500), 16–20 June, Atwpskt, was laying, but all had enlarging oviducts. Two males (110,487; 110,488) taken 17 June, Atwpskt, two (110,573; 110,574) taken 27 June 1971, 4 mi E of Winisk, and one (93,037) taken 25 June 1962, at the mouth of Sutton River, were in reproductive condition.

SLATE-COLORED JUNCO. *Junco hyemalis*. This species was very common in burned areas near HL. An adult accompanied by four juveniles was seen on 28 June 1964, Sutton Lake, and two females (94,541; 94,574) with brood patches were taken there that day. A female (94,542), HL, 3 July 1964, had a brood patch, as did one (94,543) taken there 16 July that was carrying food to young.

TREE SPARROW. *Spizella arborea*. Two nests found 26 and 27 June 1971, 4 mi E of Winisk, each contained six eggs, and were placed on the ground near the bases of small deciduous trees.

CLAY-COLORED SPARROW. *Spizella pallida*. A singing male (110,501), 21 June, Atwpskt, had left testis 8 × 5 mm, and cloaca enlarged.

WHITE-CROWNED SPARROW. *Zonotrichia leucophrys*. A female (94,546), 26 June 1964, HL, had ovaries enlarged; another (110,602), 5 July 1971, Winisk, was incubating. Four nests: HL, five eggs, clutch reported to have been complete for 5 days on 17 June 1964, five eggs 20 June, four naked young 23 June, nest empty 29 June; HL, five eggs 20–23 June, one egg, four young 26 June, four young 29 June – 1 July, nest empty, adults carrying food nearby 3 July; Sutton Lake, five eggs within 1-2 days of hatching 28 June 1964; Winisk, five eggs, embryos with some feathers 20–21 June 1965.

WHITE-THROATED SPARROW. *Zonotrichia albicollis*. A female (95,151), 15 June 1962, HL, was laying; another (94,552), 28 June 1964, Sutton Lake, had an active brood patch; two females (110,595; 110,693), 1 July 1971, Winisk, were incubating; two females, 27 May 1972, Moosonee, had ova 3 mm, one taken 30 May 1972 had three ruptured follicles (an unshelled egg in oviduct), and another taken that day had at least two ova and the oviduct enlarged. All of the many pairs of this sparrow observed at Moosonee in 1972 consisted of one tan-striped and one white-striped bird. Three nests: Atwpskt, four eggs, 4 June 1971; HL, four eggs 20–23 June 1964, nest destroyed 26 June; HL, four young with black natal down, 23 June 1964, primaries emerging, 26 June, four young and parents in the vicinity of the nest, 1 July. Nests were on the ground in areas of mixed spruce-deciduous growth. Many juveniles were seen in the Cochrane area, August 1972.

FOX SPARROW. *Passerella iliaca*. Three eggs from a nest taken 8 June 1965, Winisk, were being incubated (one showed a blood island and the others were clear). A female (110,480), 18 June, Atwpskt, had four old ruptured follicles and was incubating. A flying juvenile (110,692) was taken 1 July 1971, Winisk. A female (not saved), 1 July 1964, HL, had an active brood patch.

LINCOLN'S SPARROW. *Melospiza lincolnii*. A female (109,972), 11 June 1972, WTC, was laying; another (93,044), 22 June 1962, 54 mi NE of HL, had a brood patch. A fledgling (specimen not saved) was taken 1 July 1965, Winisk, and a nest found there 1 July 1971 contained three nearly fledged young. A nest at HL contained five eggs on 17–20 June 1964, four eggs on 23 June, and two newly hatched young on 26 June. The young were well feathered by 1 July, and the adults were feeding the young in the vicinity of the nest on 3 July. A male (94,554) taken 3 July 1964, was one of a pair with newly fledged young, and adults carrying food were seen there on 9 July 1965.

SWAMP SPARROW. *Melospiza georgiana*. A female (93,047), 2 July 1962, Hawley Lake, had an enlarged ovary; another (110,431), 16 June, Atwpskt, had three ruptured follicles and one enlarged ovum; another (110,461) taken there 17 June, had four to five ruptured follicles and a shelled egg in her oviduct. A female (114,128), 1 June 1972, WTC, was laying (unshelled egg in oviduct; three ova enlarged).

SONG SPARROW. *Melospiza melodia*. A female (95,157), 8 June 1965, Winisk, had ova enlarging.

SMITH'S LONGSPUR. *Calcarius pictus*. Three females (110,577; 110,576; 110,682), 27 June 1971, 4 mi E of Winisk, were all incubating.

Discussion

We compared the lists of birds we observed at each locality (Table 1) with each other and with published lists for four nearby localities: Churchill, Manitoba (Jehl and Smith 1970), Cape Henrietta Maria, Kenora Dist. (Peck 1972), Lake Abitibi, Cochrane District (Snyder 1928), and the "Clay Belt" of north-central Ontario and adjacent Quebec (which includes both Lake Abitibi and Cochrane) (Smith 1957). Each species was scored as present or absent at each locality; the criteria for presence were the following: for our localities, any record; for all others, a record during June or July. From Churchill, however, where the list included many more observations than from any other locality, more than five records or a nesting attempt were required for a species to be considered present. The criterion for breeding was the observation of nesting or of local juveniles, or the collection of a breeding female. Two such breeding data were required for Churchill. The 1964 and 1965 Hawley Lake lists were consolidated, and the Sutton River (SR in Table 1) records were omitted.

Between-locality comparisons were made using Jaccard's coefficient of similarity (the fraction of species occurring at either locality that is found at both), and clustered by the unweighted pair-group method (Sokal and Sneath 1963), in which groups are clustered on the basis of highest average similarity coefficient values between the members of the two groups. Some of the results are presented in Figure 1.

In the dendrogram based on the occurrence of all species (Figure 1a) the southern localities, Clay Belt (CLY), Abitibi (ABT), and Cochrane (CHN) form one cluster; Churchill (CHL) and Cape Henrietta Maria (CHM) another; and Moosonee (MSE), Attawapiskat (ATP), and Winisk a third. Hawley Lake (HL) joins the Moosonee–Winisk cluster before the Churchill – Cape Henrietta Maria cluster does, and Fort Albany (ALB) is distant from all the other lists owing to the limited migratory fauna on which it is based. When we eliminated the species reported only from other author's lists, and repeated this analysis (not illustrated), the DHB lists from Hawley Lake and Winisk (1965) clustered with Churchill and Cape Henrietta Maria rather than with the JDR–FWS lists (Moosonee, Attawapiskat, and Winisk, 1971), reflecting DHB's greater emphasis on the species Winisk and Hawley Lake share with

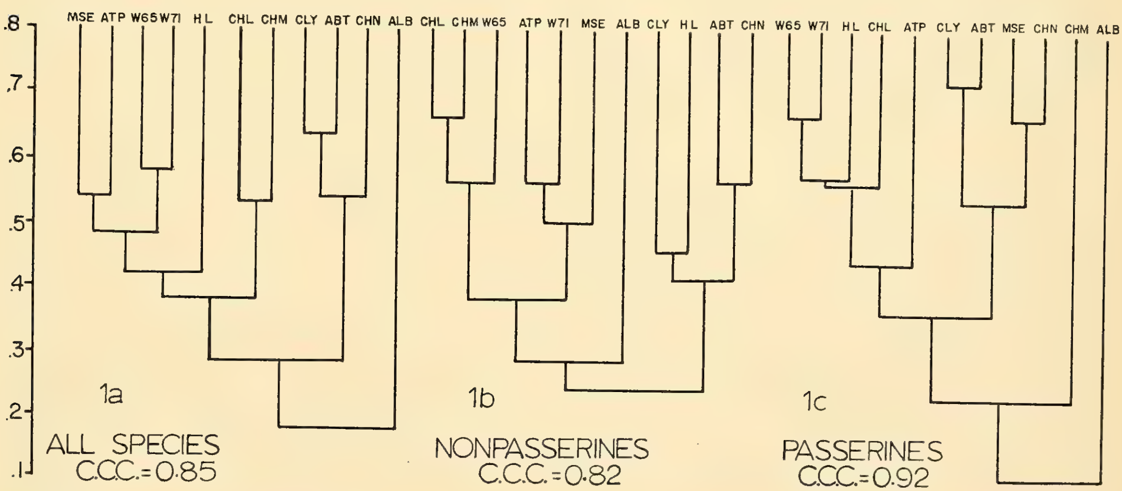

FIGURE 1. Dendrograms representing the faunal similarities among nine localities in northern Ontario and Churchill, Manitoba, as described by Jaccard's coefficient. The coefficient values are indicated by the vertical axis, and theoretically range from 0.0 to 1.0. The clustering is by the unweighted pair-group method using arithmetic averages; C. C. C. is the Cophenetic Correlation Coefficient, an estimate of the fidelity of the dendrogram to the matrix of coefficients (1.0 is perfect representation). The locality abbreviations at the tips of the "branches" are as follows: ABT = Lake Abitibi; ALB = Fort Albany; ATP = Attawapiskat; CHL = Churchill; CHM = Cape Henrietta Maria; CHN = Cochrane; CLY = Clay Belt Region; HL = Hawley Lake; MSE = Moosonee; W65 = Winisk, 1965; W71 = Winisk, 1971.

the more northern localities (largely charadriiform birds) and JDR–FWS's concentration on passerine species.

In the dendrogram based on the occurrence of nonpasserine species (Figure 1b), the coastal localities (Fort Albany, Attawapiskat, Churchill, Cape Henrietta Maria, Winisk) cluster together in opposition to the inland ones, the Winisk lists are again separated, and Hawley Lake clusters with the Clay Belt. Most nonpasserines in this region are aquatic, and they are thus more influenced by the occurrence of salt water than are the passerine species. Figure 1c, based on the passerines, unites the two Winisk lists and joins them with Hawley Lake and Churchill, joining Attawapiskat to this cluster at a fairly low level and separating it from the Moosonee–Cochrane – Clay Belt – Abitibi cluster. Cape Henrietta Maria and Fort Albany are clustered with the other localities at a very low level because of their small passerine component. The clustering of the breeding data (not illustrated) mostly showed that they were too meagre to produce any reasonable pattern.

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A Population Peak and Crash of Lemmings and Snowy Owls on Southampton Island, Northwest Territories

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Abstract. During the summer of 1970 the lemmings and Snowy Owls (*Nyctea scandiaca*) on Southampton Island experienced a population peak followed by an over-winter crash in lemming numbers and an emigration from the island by the Snowy Owls. Collared lemmings (*Dicrostonyx groenlandicus*) were more abundant than brown lemmings (*Lemmus trimucronatus*). Nesting Snowy Owls were abundant in 1970 with an average clutch of 8.1, and minimal post-hatching mortality. In the summer of 1971, no live lemmings or Snowy Owls were seen on the island.

Introduction

A barren-ground caribou (*Rangifer tarandus groenlandicus*) range-investigation of Southampton Island, Northwest Territories, provided the opportunity to observe a population peak and crash of lemmings and Snowy Owls (*Nyctea scandiaca*). The island is recognized for its high densities of arctic fox (*Alopex lagopus*) (Manning 1942) and their periodic fluctuations, which are believed dependent on the number of lemmings, their major prey species (Elton 1942). Only occasional references are made in the literature to the Snowy Owls (Sutton 1932; Bray 1943) and lemmings (Sutton 1932) of the island.

Southampton Island is the largest island in Hudson Bay (43,000 km^2) and is divisible geologically into an eastern Precambrian crystalline uplands and a western Paleozoic limestone lowlands. The physiography of the island is described by Bird (1953) and the flora by Polunin (1938, 1947, 1948), Cody (1951), and Brown (1954a, b).

A field camp was established at Salmon Pond from June 2 to August 15, 1970, and near Duke of York Bay from July 2 to August 18, 1971 (Figure 1). In addition, much of the island was observed from an aircraft at low elevation (150–300 meters above ground level) during the period August 1–31, 1971.

Lemming and Snowy Owl Numbers, 1970

The 1970 field camp was situated on an esker which projected into Salmon Pond (Figure 2). On our arrival on June 2 the spring thaw was in progress, and most elevated and exposed sites were free of snow. The abundance of lemmings was immediately evident. Burrows were abundant on the vegetated slopes of the esker, while collared lemmings (*Dicrostonyx groenlandicus*) were constantly in view.

As the snow cover continued to recede, lemmings were forced into the open, seeking shelter in any crevice available or behind rocks and under vegetation. The lake ice became dotted with lemmings, as many as 50 being within sight at one time. Many adults showed signs of fighting, such as torn ears, specks of blood on their coats, facial scars, and missing patches of fur. Fights were common, usually the result of a lemming's entering an occupied burrow.

There was a noticeable lack of fear towards our presence, most lemmings allowing an approach to within several meters before disappearing into a burrow. Lemmings were continually entering our tents, constructing nests behind boxes or under tent flaps. Only occasional *Lemmus trimucronatus* were seen. They were in the adjacent meadow and appeared much more wary.

In June 1970, 74 adult lemmings were collected at our Salmon Pond camp, using the common snap trap. The method of capture was to scare a lemming down a burrow, place the trap at the entrance, and collect the specimen a few moments later. Data on the specimens collected are presented in Table 1. Study skins and skeletal material were deposited at the National Museums of Canada, Ottawa. Embryos (six) were found in only one speci-

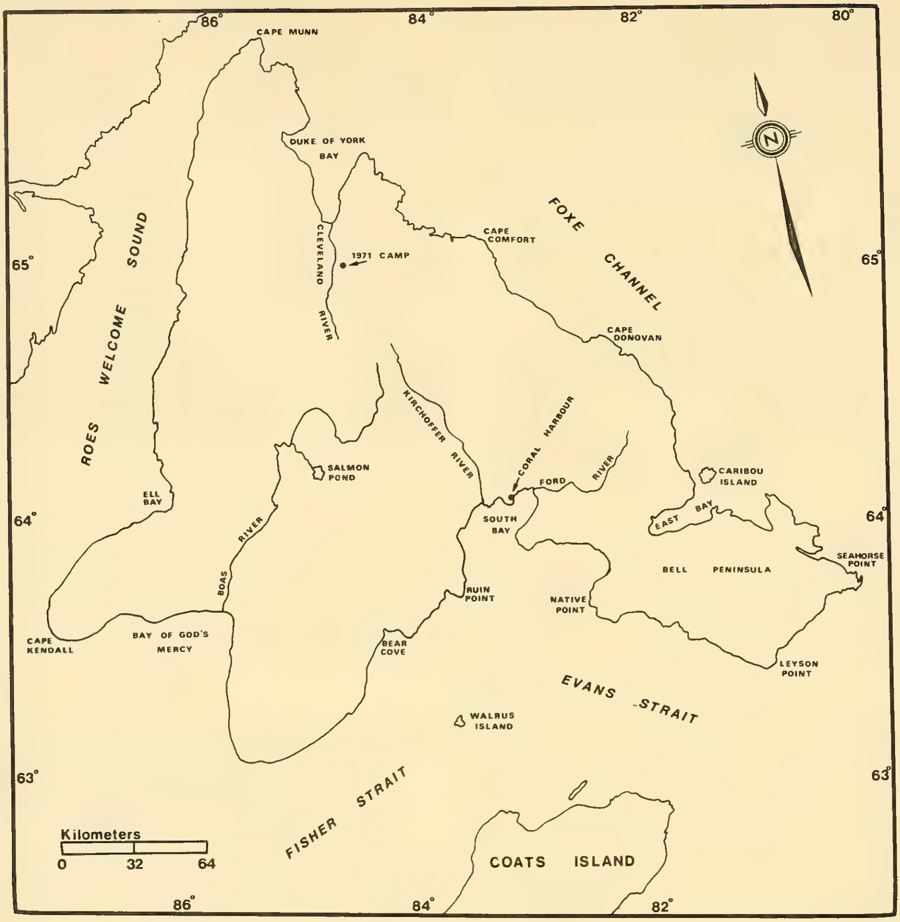

FIGURE 1. A map of Southampton Island, Northwest Territories, showing Salmon Pond, site of the 1970 camp, and the 1971 camp near Duke of York Bay.

TABLE 1—The weights and lengths of 74 adult lemmings caught at Salmon Pond, Southampton Island in June 1970

Species	Sample size	Weight (gm) Mean	Weight (gm) Standard deviation	Total length (mm) Mean	Total length (mm) Standard deviation
Dicrostonyx groenlandicus					
Male	32	61.7	12.8	130.0	8.0
Female	36	55.5	12.8	126.7	9.0
Lemmus trimucronatus					
Male	3	66.1	5.0	140.0	2.0
Female	3	62.6	12.0	131.6	2.8

FIGURE 2. The distribution of Snowy Owl nests at Salmon Pond in 1970.

men, an adult *L. trimucronatus* caught on June 5, 1970, although adults of *D. groenlandicus* were observed copulating on several occasions in late June.

A striking example of apparent extreme psychological stress was the immediate death of two *D. groenlandicus* when struck only on the forepaw by a snap trap. Both animals experienced violent shaking with legs extended, and were dead within 20–30 seconds. Lemmings caught in the open often "attacked," emitting screams and dancing forward on hind legs. No extensive movement or emigration of lemmings was observed. Lemmings wandering over the tundra and on the lake ice were apparently without burrows or territories because of the receding snow cover.

All lemmings collected were infected with ectoparasites. Specimens collected and identified were *Laelaps alaskensis, Hirstionyssus isabellinus, Haemogamasus alaskensis,* and *Parasitus* sp.

The most important predator on the lemmings in 1970 was the Snowy Owl (*Nyctea scandiaca*), although all three species of jaeger (*Stercorarius pomarinus, S. parasiticus,* and *S. longicaudus*) were present and breeding on the island (Parker and Ross 1973) and also relied extensively on the lemmings for food.

Six Snowy Owl nests were located within 6 kilometers of our Salmon Pond camp. An additional five nests were found during a trip 20 kilometers to the northeast of Salmon Pond (Figure 2). The mean distance between nests 1 to 6 was 3.5 kilometers, while between nests 9 to 11 it was 2.5 kilometers. The overall mean distance between all nests observed was 4.5 kilometers, while the shortest distance between nests was approximately 1 kilometer. All nests except No. 11 were on slightly raised gravel sites within the western limestone lowlands. Nest No. 11 was on the escarpment at the edge of a cliff-face 10 meters above a dry stream bed.

Adult males usually perched on prominent rocks on ridges within sight of the incubating female. They were often seen to capture lemmings in their talons and proceed to deposit the food at the nest for the female.

The average number of eggs for the 11 nests was 8.1, with extremes of 10 and 5. The first young owl was seen at nest No. 4 on June 30. That observation, and four young at nest No. 7 on July 2, suggests first hatching occurred during the last week of June.

Owl pellets were collected whenever possible. Pellets were commonly found on elevated ridges or other promontories within the limestone lowlands. Luxurient growth of vegetation at such observation and feeding sites showed evidence of their long use. Most such sites could be identified from considerable distance as isolated vegetation mats on an otherwise barren gravel limestone ridge. Owls occasionally accumulted large numbers of lemmings at such sites, many of which showed no signs of utilization, and others had just the head removed. Two such sites approximately 60 meters apart contained the remains of an estimated 50 lemmings.

Although most nests were not visited regularly, I believe survival of young was high. On July 17 nest No. 6 contained seven young and one unhatched egg. All young had left nest No. 1 by August 6. Only three young were located but the behavior of the adults suggested the remaining fledglings were in the immediate vicinity.

The total land area actually traversed and within which Snowy Owl nests would have been observed, was approximately 250 km², providing a density of one nest per 22 km². Within that area, assuming no mortality of young and a clutch size of 8.1, a total of 89 owls was produced, an average of one owl per 2.3 km² when adults are included.

Lemming and Snowy Owl Numbers, 1971

I again camped on Southampton Island from July 3 to August 31, 1971. Our main camp was located on the limestone lowlands at the northern end of the island near Duke of York Bay (Figure 1). During that 2-month period no live lemmings or Snowy Owls were seen, although unused lemming burrows and winter nests were abundant. Snowy Owl nest sites, apparently used the previous summer, were also common in our area.

Fifty-four dead lemmings collected in 1971 were later identified as to species. Tooth-row characteristics were the criteria used in identification, owing to the advanced decomposition of most specimens. Forty-five (83%) were *Dicrostonyx groenlandicus* and nine (17%) were *Lemmus trimucronatus*. Most specimens were collected from wet and well-vegetated sites at the base of the Precambrian escarpment, many being found in groups of three to five, curled up within or near winter nests constructed of sedges and grasses. The greatest number of dead lemmings found at one nest was seven. Carcasses were too far advanced in decomposition for autopsy.

Snowy Owl pellets were collected in 1970 and 1971. Pellets collected in 1971 were from the previous year. A total of 149 pellets was examined for food item identification. The presence of mandibles was the criterion used for determining lemming frequency per pellet. Mandibles were invariably present in pellets containing lemming hair and skeletal material. Ninety-seven percent of the pellets contained only lemmings. Ninety-six percent of the lemmings were identified as *D. groenlandicus*. Four pellets contained no lemming material; two of those contained the remains of Rock Ptarmigan (*Lagopus mutus*), one the remains of a Ruddy Turnstone (*Arenaria interpres*), and one the remains of an arctic fox (*Alopex lagopus*). Lemmings comprised 354 of 358 total food items.

Although the 1970 population of *L. trimucronatus* was much lower than that of *D. groenlandicus*, the former species apparently also experienced an over-winter decline in numbers. That assumption is not unexpected if food availability or other extrinsic factors were responsbile for the decline. Over the snow-free period, *D. groenlandicus* prefers the drier habitat while *L. trimucronatus* is normally restricted to the low-lying and wetter sites. The latter sites, however, offer the best food and cover for wintering lemmings, and in a year of such

high densities of *D. groenlandicus*, that species would be forced to move into habitat utilized by *L. trimucronatus*. The abundance of nests and carcasses of *D. groenlandicus* within the sedge meadows adds support to that assumption.

Interviews with local government personnel and Eskimo residents at Coral Harbour provided information on lemming numbers and behavior during the fall of 1970. The first snow in late September and early October appeared to trigger the crash in lemming numbers. The townsite of Coral Harbour became "infested" with lemmings, most being *D. groenlandicus*, and most persons related observations of much intraspecific strife, actual deaths during battle, and carcasses being eaten by other lemmings. Lemmings sought shelter under any object available. All persons agreed that the crash occurred around mid-October, very few lemmings being seen thereafter. One Eskimo related that while on a polar bear hunt in early October, he saw that lemming burrows were numerous in the snow, and many were ringed with blood, while at the entrance to some burrows there were dead lemmings. Less information was obtained on the Snowy Owl population but reports suggest they became scarce in the fall and disappeared about the time the lemmings declined.

Discussion

The crash in lemming numbers on Southampton Island, which occurred during the winter of 1970–1971, was the inevitable result of an exceptional population build-up. The time required for lemmings to reach such densities was not determined. Most lemmings on the island were *Dicrostonyx groenlandicus* although it is believed *Lemmus trimucronatus* also experienced a rapid increase and subsequent crash in numbers. Representation of the latter species was 8% of lemmings collected in 1970, 4% of total lemmings identified in Snowy Owl pellets, and 17% of the lemming carcasses examined in 1971.

Recent theories advanced to explain population fluctuation by lemmings are reviewed by Christian and Davis (1964), Krebs (1964), and Clough (1965). My observations suggest that a combination of factors were responsible for the over-winter crash in lemmings.

A considerable degree of stress was evident from the unusual behavior of lemmings in the summer and fall of 1970. The eating of dead lemmings by *D. groenlandicus* has also been reported for *L. trimucronatus* in Alaska (Thompson 1955).

The abundance of dead lemmings in 1971 suggested a lack of winter food was also a contributing factor to the crash, agreeing with the food-supply hypothesis by Lack (1954). Carcasses were often found at the base of slopes, such sites supporting arctic heather (*Cassiope tetragona*), a plant species indicative of a heavy covering of snow which would provide protection for the wintering lemmings. Creeping willows (*Salix reticulata* and *S. arctophila*) near old nest sites were usually devoid of bark, while much of the green growth of sedges (*Carex* spp.) showed evidence of having been eaten back during the winter. The plant *Silene acaulis* was also used extensively, either as food or as nest material. Most lemmings were found near or curled up within winter nests.

I agree with the conclusion by Krebs (1964) that the genetic polymorphic theory of Chitty (1960) is the most plausible explanation for fluctuations in lemming numbers. That theory contends that a build-up in animal numbers coincides with a deterioration in the quality of the population, and increases the importance of climate as the ultimate limiting factor.

The total snowfall during the winter of 1970–1971 at Coral Harbour was 146.5 cm (Atmospheric Environment Service, personal communication), greater than the recorded mean of 134.8 cm (Thompson 1967). Although the snowfall for September 1970 was considerably less than average (2.2 cm versus 9.1 cm), the mean daily temperature for that month was similar to the long-term mean (1.22°C versus 1.27°C). An above-average snowfall occurred in October (40.6 cm versus 27.1 cm), and by the end of the month 20.3 cm of snow was recorded on the ground.

It is possible that the crash began with the onset of cold temperatures in September and October and, combined with the sparseness of snow cover and depletion of available forage, lemmings succumbed to "cold-weather starvation," as described by Thompson (1955). Such a phenomenon would be in agreement with the genetic polymorphic theory and would explain the lack of any apparent differences in local climate between years of lemming scarcity and abundance. Lemmings experimentally deprived of sufficient food during August in Alaska showed symptoms of shock in 6 hours and died within 24 hours but lost only 10% of the original

subcutaneous fat (Thompson 1955). Wild populations experiencing genetic deterioration could be expected to succumb under less strenuous conditions. That would explain the lack of emaciated or physically abnormal individuals during a population crash, a criticism by Krebs (1964) of the food-supply hypothesis.

I believe most lemmings on Southampton Island succumbed to exposure and malnutrition during the winter of 1970–1971. This did not result from complete depletion of the food resources nor from an unusually severe winter, but from a failure of lemmings to maintain normal tolerance levels through genetic deterioration following a rapid population build-up.

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Evidence for Underground Movement of Fishes in Wood Buffalo National Park, Canada, with Notes on Recent Collections Made in the Park

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Abstract. Four species of fish (finescale dace, pearl dace, brook stickleback, and ninespine stickleback) occur in a small pool in a recent sinkhole lacking surface drainage, in northern Wood Buffalo National Park. Access into this sinkhole was almost certainly gained through an underground channel from the Klewi River, about 275 m (300 yards) away. Individuals in the sinkhole probably lead a precarious existence; numerous dead were observed. Certain other sinkholes may also have received their fish fauna through underground channels. Additional localities have been found with sticklebacks lacking the pelvic skeleton.

Introduction

The sinkhole region in Wood Buffalo National Park, Alberta and Northwest Territories, has many interesting features to the ichthyologist, as shown in two previous collecting trips of the authors in 1970 and 1971 (Nelson and Paetz 1972). There are extensive salt flats with streams of high sodium chloride concentrations (Drake 1970; Nelson and Paetz 1972; Reeder et al. 1972), and karst topography with numerous sinkholes which are still being produced and possibly have been produced since Cretaceous times (Bayrock 1970). Fish exist in some of the salt streams and in many sinkhole lakes. In addition, in several localities there are two species of sticklebacks in which a high proportion of the individuals lack the pelvic skeleton. It is an area where several species reach their range limits, while several widespread species in surrounding areas are very restricted or absent.

This paper presents evidence for underground movement of fishes into at least one sinkhole, gives additional locality records for sticklebacks lacking a complete pelvic skeleton, and comments on the nature of the fish fauna in northern Wood Buffalo National Park.

Materials and Methods

Fishes were collected June 24–26, 1972, and June 23–26, 1973. A helicopter was used in both years to reach some sites. Some trips were made to lakes west of the sinkhole region and east of the Slave River and to the Nyarling River, but these yielded little new or unexpected information and are thus not enlarged upon. The methods of collecting were the same as described by Nelson and Paetz (1972). Rope and ladders were employed for descending into the Klewi sinkhole.

Specimens are deposited in The University of Alberta Museum of Zoology (UAMZ 3124 to 3144 for 1972 and UAMZ 3213 to 3219, accession number 73-86, for 1973).

Results and Discussion

Numerous sinkhole lakes, some of which were examined, exist in an area from 5 km (3 miles) northwest of Peace Point (59°09′ N, 112°29′ W), extending northeast towards the vicinity of Lane Lake and the headwaters of the Hornaday River, to the area around the Nyarling lookout tower (Angus Tower) (approximately 60°27′ N, 114°17′ W). (Bayrock (1970) presents details of sinkhole occurrence in the Alberta portion.) Caves and fissures also exist in some areas of this zone (e.g., 59°10′ N, 112°29′ W; and 59°49′ N, 111°57′ W). The bedrock is Devonian limestone and gypsum with glacial till and aeolian sand overburden. Many sinks are small depressions (often 1 to several meters deep) lacking water, while others penetrate the water table and hold water the year round. We have collected fish specimens from three types of sinkhole lakes. One type has exposed precipitous (sheared) sides with water only in the bottom; the second has steep sides but the water is filled to the top, leaving little or no littoral zone. The third, the largest and most

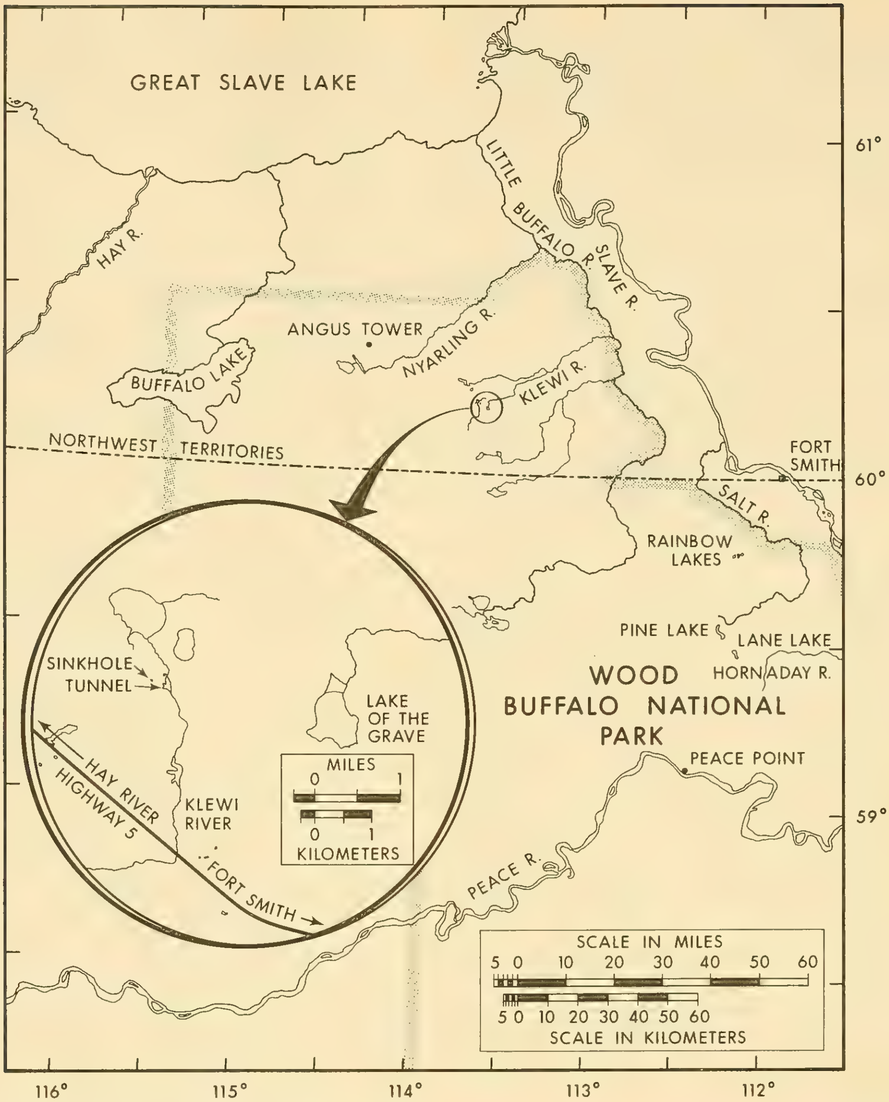

FIGURE 1. Map of Wood Buffalo National Park showing localities mentioned in the text. Inset map shows location of the sinkhole (shown in Figures 2 and 3) from which fish were collected, and the nearby tunnel (shown in Figure 4). Numerous other sinkholes exist within the inset map area, especially to the north-northwest of the indicated sinkhole.

productive type, has water over the sides of the sink (often more than one sink are joined), usually leaving a well developed littoral zone with aquatic plants (e.g., Pine, Lane, Rainbow Lakes). All of these sinkhole lakes tend to be relatively small in area, relatively deep (Pine Lake has a maximum depth of 24 m), and clear. On the other hand, many lakes which are large by comparison occur immediately to the west and east of the sinkhole region. To the west their waters tend to be murky and shallow (with depths often of about 1–3 m) and depauperate in fish, while to the east of the Slave River lie numerous deep clear lakes on igneous bedrock in the Precambrian Shield with a good predator and prey fish fauna (the native fishes of sinkholes tend to be small prey species). Whereas

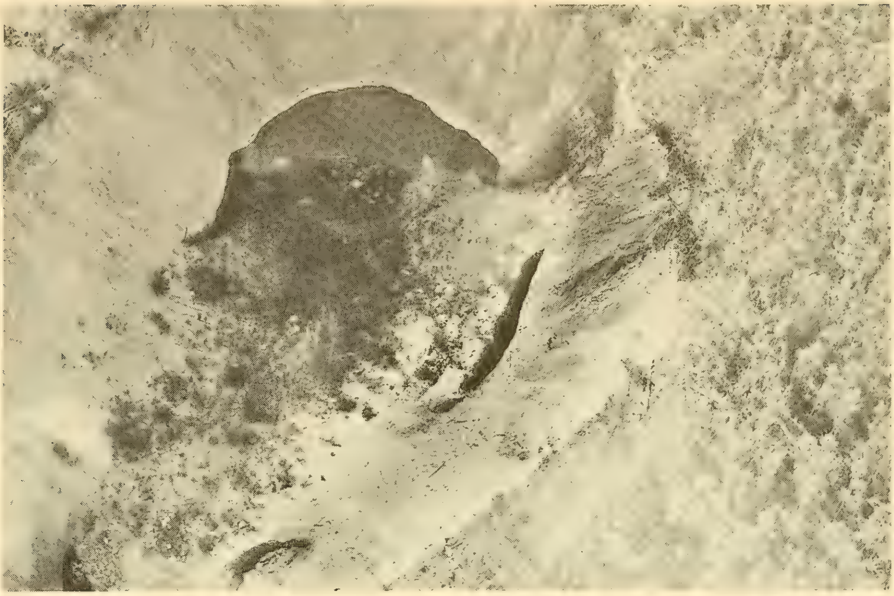

FIGURE 2. Circular, collapse sinkhole at 60°12′ N latitude and 113°42½′ W longitude indicated in Figure 1. June 24, 1972.

surface drainage in the above two lake zones is well developed, it is very poorly developed in the sinkhole zone, with the sinkhole lakes usually lacking surface inlets or outlets. Fishes have not been found in all sinkhole lakes.

The most convincing case found of inferred underground movement of fishes is that of a sinkhole in the Klewi system at 60°12′ N, 113°42½′ W (Figure 1). This sinkhole is approximately 45 m (150 feet) by 30 m (100 feet), with the long axis lying in a northwest-to-southeast direction (Figure 2). The sides consist of much loose material and the central area is filled in with material which was solid enough to walk on. The maximum depth from top to the water level is about 18 m (60 feet). At the southeast end (lower left in Figure 2), closest to the Klewi River, is a small opening which was not investigated by us, while a readily accessible pool exists in a tunnel-like entrance at the northwest end (top center in Figure 2). Light breezes brought down a shower of fine dust particles into the water, but most of the pool was under a ledge. No rooted aquatic plants were visible and no currents were detectable. It was in the northwest pool (Figure 3)

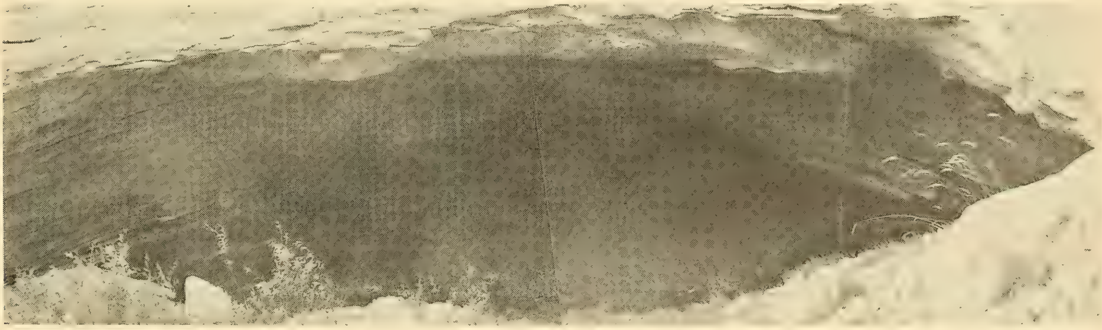

FIGURE 3. View of pool from which four species of fish were collected in sinkhole indicated in Figure 1. June 26, 1973.

FIGURE 4. Mouth area of underground tunnel (roof collapsed) in Klewi drainage near 60°12′ N latitude and 113°42¼′ W longitude, indicated in Figure 1. Pool in foreground is part of a sinkhole. June 24, 1972.

that a relatively large number of fish occurred. Numerous dead, some of which had fungus, lay on the bottom. Many of the live fish appeared weak and emaciated. Specimens of finescale dace (*Chrosomus neogaeus*), pearl dace (*Semotilus margarita*), brook stickleback (*Culaea inconstans*), and ninespine stickleback (*Pungitius pungitius*) were obtained (Table 1A). The two ninespine sticklebacks lacked the entire pelvic skeleton. Our observations on the habitat provided by the pool and the condition of the fish, suggest to us that the fish lead a very precarious existence.

TABLE 1 — Fishes collected from the sinkhole indicated in Figure 1 and from the adjacent tunnel-like entrance off the Klewi River. Year of collection is indicated after the locality.

Species	Number	Standard length (mm)
A. Klewi sinkhole (1973)		
Finescale dace	161	28–37 (two dead were 55)
Pearl dace	6	37–49
Brook stickleback	65	20–44
Ninespine stickleback	2	25–35
B. Klewi River (1972)		
Finescale dace	5	40–45
Pearl dace	7	55–88
Brook stickleback	26	13–43

About 275 m (900 feet) in an east-southeast direction (about 115°) from the sinkhole there is a tunnel-like opening in an exposed vertical rock formation (Figure 4). The water in the tunnel is an extension of a ground-level sinkhole which is adjacent to the Klewi River (really a small creek). The tunnel is caved in a short distance from the opening but appears to run in towards the sinkhole. Again, no currents were apparent. The fishes collected off the tunnel opening are listed in Table 1B. The sticklebacks were much plumper than the ones in the sinkhole.

A water sample from the sinkhole showed calcium and sulphate to be the dominant cation and anion, respectively (Table 2), as is true for other tributaries of the Little Buffalo River (Nelson and Paetz 1972), but quite unlike the ratio of ions in the Salt River system. The sinkhole sample was higher in all ions than that from the Klewi River (Table 2), and the total dissolved solids (1,870 ppm) is much higher than that found in most inland waters.

The geography of the area and apparent recency of the sinkhole precludes, in our minds, the possibil-

TABLE 2 — Chemical analysis of water samples from the Klewi sinkhole (sample taken by us and analyzed by the Pollution Control Division Laboratory, Alberta Department of Environment) and the Klewi River (data from Dr. R. Green, Alberta Research Council). Variables are in ppm (parts per million).

Variable	Klewi sinkhole (1973)	Klewi River at Highway 5 (1970)
Total dissolved solids	1,870	944
Total hardness ($CaCO_3$)	1,409	635
Total alkalinity ($CaCO_3$)	173	116
Na	9	3.8
K	2.7	2.5
Mg	87	30
Ca	421	204
Cl	6	3
SO_4	1,125	481
HCO_3	210	116

ity of surface movement (which is possible in some other sinkhole lakes). There seems little reason to doubt that the fish in the sinkhole lake arrived there by passing through the above tunnel system from the Klewi (it is indeed possible that some fish have a subterranean existence). The only three species collected in the adjacent Klewi were also in the sinkhole. We can only surmise that ninespine stickleback also gained entry this way although we have not collected them elsewhere from Little Buffalo drainage.

The Rainbow Lakes are sinks lying in low hills with no surface drainage in the immediate vicinity. Whether or not the native fishes, fathead minnow (*Pimephales promelas*), northern redbelly dace (*Chrosomus eos*), and brook stickleback reached them by underground drainage or through some past surface drainage shortly after glacial retreat is not certain. The very selective nature of the fish fauna (i.e., none of the large species which are common in surrounding areas) makes a subterranean route seem plausible for the Rainbow Lakes and a few other sinkhole lakes.

Sticklebacks lacking the pelvic skeleton or part of it were found in a few localities not covered in our earlier study (Nelson and Paetz 1972). In a tributary to the Salt River (approximately 59°56′ N, 112°25′W), of some 38 ninespine stickleback, five had the entire pelvic skeleton missing and three lacked one spine, while of 23 brook stickleback, one lacked one spine. Lane Lake (59°28′ N, 112°10′ W) contained Iowa darter (*Etheostoma exile*) (83 collected) and ninespine and brook sticklebacks. Of 10 ninespine stickleback, seven lacked the pelvic skeleton, two lacked one spine, and one was complete, while all 60 brook stickleback lacked the entire pelvic skeleton. An unnamed sinkhole in a muskeg area (about 59°26′ N, 112°04′ W) contained northern pike (*Esox lucius*), Iowa darter, and brook stickleback (the three collected lacked the pelvic skeleton). Surface invasion seems most reasonable for this sinkhole since it does have a good inlet and lies close to the Hornaday system. The 42 brook stickleback collected from another nearby sinkhole (59°24′ N, 112°06′ W) all had complete pelvic skeletons. The ninespine sticklebacks lacking the pelvic skeleton from the Klewi sinkhole have already been mentioned.

Brook sticklebacks with the same skeletal deficiency as in Wood Buffalo National Park are known from central Alberta and Saskatchewan while similar ninespine sticklebacks are known from Ireland. Individuals without the pelvic skeleton of these two sticklebacks very rarely occur in other parts of Canada (Nelson and Atton 1971; Coad 1973). Recently Stephanidis (1971) has described what he believes to be a new species of stickleback, *Pungitius hellenicus,* from Greece on the basis of a nearly absent pelvic skeleton. This phenomenon is an interesting case of parallel evolution which lacks explanation at present. Although it is not entirely known whether the absence of the pelvic skeleton is largely non-genetic (e.g., due to a nutritional deficiency) or genetic, some crosses made with brook sticklebacks by one of us (J.S.N.) strongly suggest that there is a genetic component. Possibly the observation that individuals in Wood Buffalo without the skeleton tend to occur in areas lacking natural fish predators will be found to bear some relation to the selective forces responsible for the skeletal deficiency, with the greater variability of expression occurring only in those areas where selective pressures strongly favoring its full development are relaxed.

Nelson and Paetz (1972) noted that the northeastern Wood Buffalo National Park area contained an unusual assemblage of fishes. Many species occur around the area but are not in the sinkholes. We noted that five species have their northern range limits in the park area. Of these five, two (northern redbelly dace and brook stickleback) have been found at localities along the Mackenzie River as a result of the detailed fish studies for the Task Force on Northern Oil Development (Stein et al. 1973).

Their work has also produced other significant range extensions. Present information still suggests that fathead minnow, pearl dace, and Iowa darter have their northern limits in the Wood Buffalo area and are locally very abundant. Iowa darter were previously known only from Pine Lake in the park but we now have them from Lane Lake and the inlet of the unnamed sinkhole at 59°21′ N, 112°04′ W. They are very abundant at all three sites.

Acknowledgments

We are grateful to the former superintendent of Wood Buffalo National Park, Mr. Tom W. Smith; the former Chief Park Warden, Mr. Ken F. Cooper; the present superintendent, Mr. R. B. Mitchell; and to the Western Regional Director of the National and Historic Parks Branch, Department of Indian and Northern Affairs, for permission to work in Wood Buffalo National Park.

The manuscript was kindly read by Messrs. K. F. Cooper and D. W. Hodgins of Wood Buffalo National Park.

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Annual Production of Fledged Young from the Eider Colonies of the St. Lawrence Estuary

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Milne, H. and A. Reed. 1974. Annual production of fledged young from the eider colonies of the St. Lawrence estuary. Canadian Field-Naturalist 88: 163-169.

Abstract. The total breeding population of eiders on the islands of the lower St. Lawrence estuary was estimated, from nest counts, as at least 20,000 pairs. Mean clutch size on open grassy islands was 3.37, and was significantly smaller than the mean on grassy, shrubby islands (3.76) and wooded islands (3.74). The total egg production for all islands was estimated at about 73,500 from which an estimated 24,800 ducklings were hatched. Hatching success varied from 15% on open habitat, to about 30% on grassy, shrubby islands, and 36% on wooded islands. Most of the egg losses were thought to be due to predation by gulls, and was associated with the amount of overhead cover and human disturbance. About 6000 ducklings (24.5%) are thought to have survived to fledging, and represented an average of 0.3 ducklings per pair, compared to 0.26 per pair from a population of *Somateria mollissima mollissima* in Scotland where clutch size was higher, hatching success was higher, and duckling survival lower than the corresponding values in the St. Lawrence.

Several communications over the past few decades have been concerned with various aspects of the breeding biology of the Common Eider (*Somateria mollissima dresseri*) on the east coast of North America, but none have assessed the overall production of fledged young from any given population (cf. Gross 1938, 1944; Lewis 1939; Paynter 1951; Choate 1967; Guignion 1968; Reed 1973). This article represents an attempt to synthesize the relevant data on breeding numbers, clutch size, hatching success, and duckling survival known from a variety of studies carried out on some of the

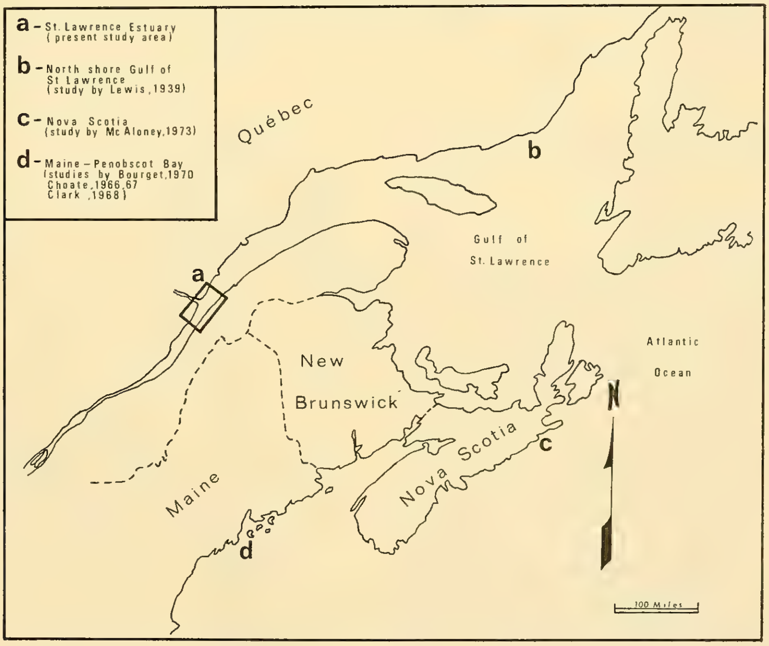

FIGURE 1. Map of eastern North America, where a, b, c, and d represent areas in which studies of *Somateria mollissimia dresseri* have been conducted.

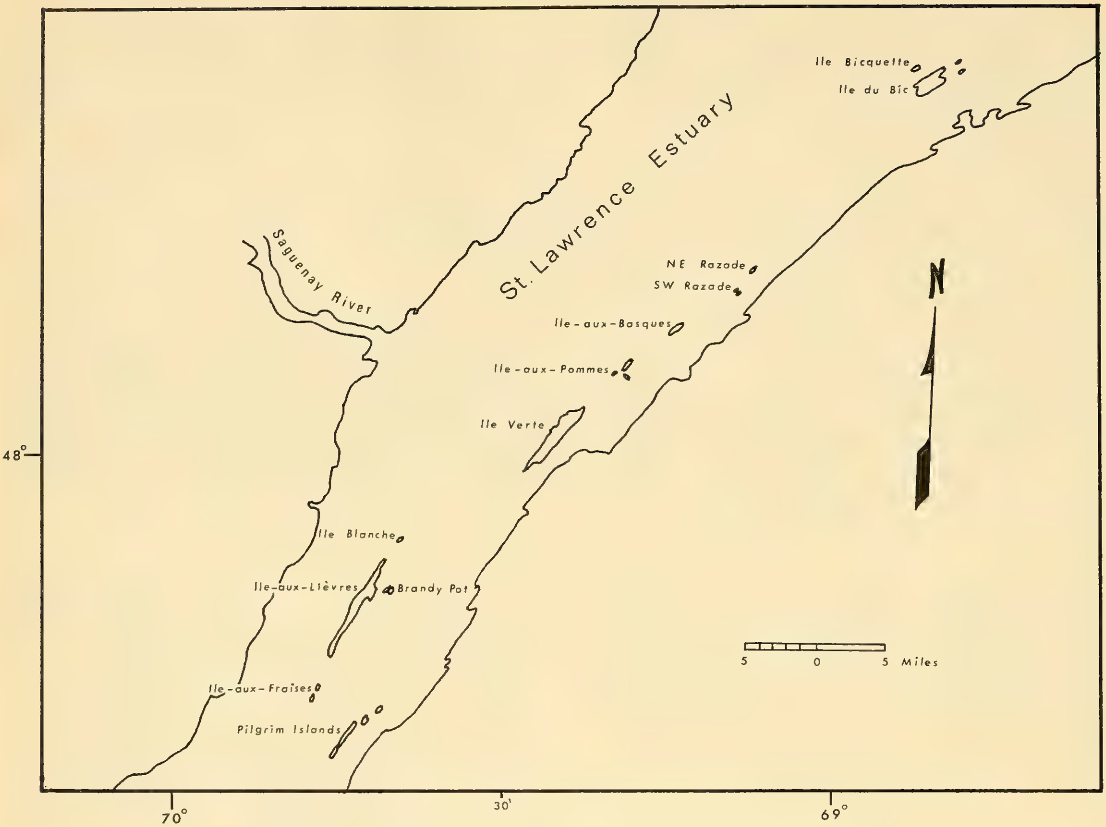

FIGURE 2. Map of the St. Lawrence estuary, the present study area.

islands and adjacent coastlines, in the estuary and Gulf of St. Lawrence (Figures 1 and 2).

Method and Observations

During the period 1963 to 1972 data were collected by Reed (1973) on the estimated numbers of breeding eiders in most of the island colonies from the Kamouraska Islands to Ile-du-Bic. In addition, observations on clutch size were made by Reed whenever nest censuses were carried out, and comparative data are available from an intensive study made by Guignion (1968) on three selected islands. Clutch size and hatching success values are known from Ile-aux-Pommes and Northeast Razade (Reed, this study) while Guignion (1967) has provided similar information for Brandypot, Little Pot, and Southwest Razade. Observations relating to the survival of ducklings are limited to those from current studies at Université Laval by Bédard, Munro and Gauthier, and to those of McAloney (1973), who measured duckling survival on the coast of Nova Scotia.

Since data on these various stages of reproduction relate only to a sample of islands, we have grouped the islands into three categories according to the amounts and type of vegetative cover for breeding eiders (see Reed (1973) for detailed descriptions of vegetation):

(*a*) small rocky islets with sparse grass cover (e.g., the Razades),

(*b*) islands with grass and shrubby vegetation (e.g., Ile-aux-Pommes, Ile-aux-Fraises),

(*c*) islands with stands of trees, giving complete overhead cover (e.g., Bicquette, Ile Blanche, Brandypot, Little Pot, Pilgrim Islands).

Breeding Numbers

All estimates of the numbers of breeding pairs are based on total nest counts, or estimates from sample

plots, made at the time of the peak of incubation (see Reed (1973) for details of methods). These estimates provide only a measure of the number of nests which were occupied at the time of each census and give no correction for previously abandoned or destroyed nests, nor of late nests. The numbers of breeding pairs (Table 1) should therefore be regarded as minimal.

(*a*) Open grassy islands—present populations on the Razades, and Lark Islet when combined, number only about 700 pairs.

(*b*) Islands with grass and shrubs—the two main breeding populations on this type of island are found on Ile-aux-Pommes and Ile-aux-Fraises. The combined estimate for these two islands gave 4700 pairs.

(*c*) Wooded islands—these are the most numerous of the islands used by eiders in the estuary and altogether provide more than 14,000 pairs of birds. This includes an estimated 7400 on Bicquette.

The three types of islands in the estuary account for roughly 19,700 nesting pairs; scattered nesting occurs in other sites, which would raise the estimate to approximately 20,000 pairs.

Clutch Size

Data on clutch size are available for several years on a variety of islands. In most cases there are no significant differences between years on the same island and we have, therefore, lumped the data to get overall means for these islands (Table 2). Since there were no significant differences between clutches on islands of the same cover type, we have again combined these data to obtain mean values of clutch size for each of the three island-types. There is a statistically significant difference between the mean for open grassy islands and the other two types ($t = 1.96, P < .001$).

TABLE 1 — Estimated numbers of nesting pairs of eiders on the islands of the St. Lawrence estuary

Type of habitat	Island	Number of pairs	
Open, grassy	NE Razade	300	
	SW Razade	250	700
	Lark Islet	150	
Grass and shrubs	Ile-aux-Pommes	2400	4700
	Ile-aux Fraises	2300	
Wooded	Bicquette and reefs	7400	
	Ilets of Baie-du-Bic	150	
	Ilets d'Amours	50	
	Ile-aux-Basques	150	14,300
	Ile Blanche	3800	
	Brandypot, Little Pot	1250	
	Pilgrim Islands	1000	
	Kamouraska Islands	500	
Total		19,700	

Egg Production

Egg production was calculated on the basis of the average of yearly estimates of numbers of breeding pairs on each of the islands and the mean clutch size for the appropriate cover type (Table 3).

Hatching Success

There were clear differences in the amount of egg predation by nesting gulls on the different islands. In the open habitat of the Razades, where Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*L. marinus*) nest in mixed colonies with the eiders, extremely high losses were encountered, especially after human disturbance. Such heavy predation of eggs may also explain the smaller clutch size found on the Razades compared with the other islands.

Guignion's (1967) study of nesting success on Southwest Razade revealed that only 15.5% of all eggs laid were hatched, compared with 33.8% on Little Pot and 52% on the Lighthouse Pot (average for the two, 35.8%). Further studies on Northeast Razade (Reed, this study) indicated a success rate of 14.4%. Reed's observations on Ile-aux-Pommes in 1963 and 1971 showed a hatching success of 25–35%, intermediate between that of the Razades and Brandypot. These results suggest a direct relationship between the amount of overhead cover for nesting eiders and the hatching success of the eggs. This, in the presence of nesting gulls on most of the islands, presumably indicates a measure of the vulnerability of eggs in the more open habitats.

An estimate of total duckling production has been made, based on the calculated egg production and the values of hatching success in the three categories of nesting habitat (Table 4). This estimate represents an average figure over recent years, since egg production is based on average figures (both numbers of pairs and clutch size). When annual values of pair numbers and clutch size are substituted in the calculations (which was only possible for 1966 and 1972, years of intensive surveys) only slight changes result; duckling production was calculated

TABLE 2 — Clutch size of Common Eiders in the St. Lawrence estuary, 1963-1972

Type of habitat	Island	Year	Number of nests	Mean number of eggs per nests	Standard deviation
Open, grassy island	NE Razade	1966	311	3.15	1.3519
		1969	351	3.11	1.2729
		1971	236	3.25	1.2944
		1972	225	3.67*	1.4815
		Combined	1123	3.26	1.3580
	SW Razade	1963	73	3.52	1.5905
		1965**	—	3.60	—
		1966	268	3.27	1.3327
		1969	350	3.20	1.2907
		1970	273	3.64	1.4940
		1971	196	3.75	1.4793
		1972	271	3.58	1.5371
		Combined	1431	3.46	1.4420
	Both Razades, all years combined		2554	3.37	1.4088
Grassy, shrubby island	Ile-aux-Pommes	1963	190	3.60	1.7785
		1966	614	3.58	1.4184
		1968	541	3.79	1.4095
		1969	385	3.79	1.3490
		1970	240	3.68	1.3350
		1971	263	3.82	1.3297
		1972	387	4.11*	1.2987
		Combined	2623	3.77	1.4121
	Ile-aux-Fraises	1965	65	3.52	1.1740
		1966	10	3.34	1.1595
		1972	171	3.74	1.2299
		Combined	246	3.66	1.2139
	Both islands, all years combined		2869	3.76	1.3959
Wooded island	Bicquette	1972	881	3.82	1.4849
	Ile-aux-Basques	1965	89	3.94	1.2000
		1966	47	3.47	1.3964
		1968	58	3.81	1.4199
		Combined	194	3.79	1.3240
	Ilets d'Amours	1965	8	3.13	1.4577
		1966	26	3.88	1.1429
		1968	24	4.08	1.3486
		1969	46	3.85	1.3494
		Combined	105	3.85	1.3066
	Little Pot	1966**	—	3.80	—
		1972	42	3.80	1.2733
	Ile Blanche	1966	126	3.25	1.2260
		1972	150	3.50	1.3044
		Combined	276	3.39	1.2728
	All wooded islands, all years combined		1521	3.74	1.4208

*Significantly greater than all other years.
**According to Guignion (1967).

TABLE 3 — Calculated egg production on all islands in 1972

Island group	Total breeding pairs	Mean clutch size	Total egg production
Open, grassy islands	700	3.37	2359
Grassy, shrubby islands	4700	3.76	17,670
Wooded islands	14,300	3.74	53,480
Total			73,509

TABLE 4 — Calculated duckling production from the eider colonies in 1972

Type of habitat	Number of eggs laid	Percent hatching success	Calculated duckling production	Ducklings per nest
Open, grassy islands	2359	15.5	366	0.5
Grassy, shrubby islands	17,670	30	5301	1.1
Wooded islands	53,480	35.8	19,146	1.3
Total			24,813	

to be 24,300 and 25,600 in 1966 and 1972 respectively, compared to the average of 24,800.

Duckling Survival

To date, the only critical evaluation of survival of ducklings of this subspecies has been made by McAloney (1973) in Nova Scotia in 1970–1971. His data indicate a survival to fledging of 24.5%. Assuming this to be representative of the situation in the estuary, we estimate that on average 6,100 ducklings survive to fledging, representing a mean of 0.3 fledged young per pair. Preliminary examination of Gauthier's 1972 brood census data for the St. Lawrence estuary (J. Gauthier, personnal communication) suggest that this figure is plausible.

Discussion

The data presented here on clutch size are subject to all of the criticisms regarding partial predation and multiple layings, which have previously been made (e.g., Guignion 1967, 1968; Choate 1967; Marshall 1967; Clark 1968; Bourget 1970; Ahlén and Andersson 1970). Only with a great deal of effort, however, could these figures have been corrected, and Guignion (1967) has indicated that partial predation may account for only a relatively small number of eggs on wooded islands. Reed's 1963 data for Ile-aux-Pommes indicate that partial predation and embryonic mortality account for a loss of 8.7% of eggs in successful clutches. From Choate (1966) it appears that about 5% of eggs laid may be lost as a result of partial predation on islands where the vegetative cover was similar to that on Ile-aux-Pommes and where gulls were nesting in mixed colonies with the eiders, as they are in the St. Lawrence.

Our mean clutch-size value of 3.76 for Ile-aux-Pommes and Ile-aux-Fraises is extremely close to the 3.8 quoted by Choate (1966) from islands in Maine with similar amounts of cover, and is only slightly lower than values given by Milne (1974) for *S. m. mollissima* in Scotland; he found an overall mean of 4.11 (10-year average). On islands off the north shore of the gulf of St. Lawrence, several hundred miles downstream from the present study area, Lewis (1939) recorded a clutch size of 4.04 for *S. m. dresseri*.

Hatching success on the Razades was very low (15.5%) but is again in agreement with the findings of Choate (1966), Clark (1968), and Bourget (1970) for the breeding colonies of Penobscot Bay where there was little cover and Herring Gulls were present in large numbers. It is of interest to speculate on the decline in the number of eiders nesting on the Razades over the past 34 years (Reed 1973), at a time when all other breeding units in the estuary appear to have either increased in size, or at least maintained numbers. During the same period the gulls have increased their numbers and may well

TABLE 5 — Summary of reproductive rates of eiders in the St. Lawrence estuary compared to those of northeast Scotland

Region	Estimated breeding numbers	Mean clutch size	Percent mean hatching success	Percent duckling survival	Mean number ducklings/ pair
St. Lawrence	19,700	3.8	30	24.5	0.31
Forvie, Scotland	2000	4.11	63	10	0.26

have effected the decline of the eiders on the Razades. Clark (1968), who recorded a nesting success rate of 15% on Goose Island, Maine, attributed the low value mainly to the lack of nest concealment from predators.

The general gradation of hatching success found through the three categories of island can be attributed to the degree of nest concealment as well as to a corresponding gradation of density of breeding gulls. Our intermediate value from Ile-aux-Pommes of 30% is comparable with the 35% found by Choate (1966) and 38% by Clark (1968) on similar islands off the coast of Maine.

The average duckling production per nest varied from 0.5 on the Razades to 1.3 on the wooded islands and is low when compared with the 1.4 from Maine (Choate 1966), 2.6 for *S. m. mollissima* in Scotland (an 8-year average) (from Milne 1974) and 1.9 (*S. m. mollissima*) on Spitsbergen (Ahlén and Andersson 1970).

Comparative data on duckling survival are lacking from most areas. Our estimate of 24.5% survival of ducklings to fledging depends on the assumption that duckling survival in the St. Lawrence is similar to that found off the coast of Nova Scotia, but current studies by Gauthier (personal communication) indicate that this assumption may be sound. These observations, however, show a much higher duckling survival than the 10% (10-year average) recorded for *S. m. mollissima* by Milne (1973), unless a longer-term study were to show similar variation between years as that demonstrated by Milne (1974) does.

The overall mean production of 0.30 fledged young per pair from the St. Lawrence colonies, and 0.26 per pair from the Forvie colony in Scotland, is of considerable biological significance. In these two similar subspecies nesting in different habitats, where predation on eggs is extremely high in the case of the St. Lawrence, but where duckling mortality is not so high as it is at Forvie, the average output of young per pair is very similar (Table 5).

These observations suggest that if the production of fledged young per breeding pair for the various subspecies of the Common Eider is similar, then we may be able to make predictions on one or more of the unknowns for any given population, by making measurements of only some of these parameters. Such exercises would be useful in formulating management programs.

Acknowledgments

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Some Aspects of the Distribution and Ecology of Crowberry, *Empetrum nigrum* L., on the North Shore of Lake Superior

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Abstract. Aspects of the ecology and distribution of crowberry, *Empetrum nigrum* L. (*sensu latu*) an arctic-alpine plant, have been studied on a small island on the north shore of Lake Superior. Presence and biomass samples show *E. nigrum* to be a component of a forest and a krummholz community, being best represented in the latter. Species relationships in the communities are outlined, as are soil and temperature conditions. A sere is hypothesized: (1) Gravel beach, (2) Lichen – dwarf shrub heath, (3) Krummholz, (4) Conifer forest. *Empetrum nigrum* is a part of at least the last two stages.

Introduction

Black crowberry, *Empetrum nigrum* L. (*sensu latu*), is a creeping mat-forming, microphyllous, evergreen dwarf shrub. It is a circumpolar species that is widely distributed in northern Canada, Greenland, and Alaska (Porsild 1964). It is also widely distributed in Canada's Boreal, Sub-alpine, and Coast forest regions (Lyons 1952; Scoggan 1957; Moss 1959; Boivin 1967). In interior regions *E. nigrum* tends to be associated with larger lakes, peat bogs, and moist coniferous forests. Its most southerly extensions are associated with bodies of water large enough to modify the local climate significantly. For example, *E. nigrum* is found at the 49th parallel in British Columbia in peat bogs near Ucluelet, and on the Pacific coast it is found as far south as Del Norte County in California (Hitchcock and Cronquist 1961); in eastern North America *E. nigrum* is present in Quebec (the Magdalen Islands), Newfoundland, and all the Maritime Provinces (Boivin 1967); and also on the coast of Maine and at isolated high elevations in New England (Soper and Voss 1964). In Manitoba southerly extensions are all associated with large lakes. There are collections by Scoggan and Baldwin (University of Manitoba No. 2343) from Lake Winnipegosis, and much further south, by Jackson and Higham (University of Manitoba Nos. 2350, 2351, 2352), from Victoria Beach on the south end of Lake Winnipeg.

In the Lake Superior region all records are associated with large bodies of water. All records are also associated with Lake Superior, except for a collection from the east shore of Lake Nipigon (Soper and Voss 1964). The Clay Belt to the north of the Superior region, in spite of a careful search, has not produced any specimens of *E. nigrum* (Baldwin 1958). In Minnesota only Cook County in the extreme northeastern and Superior-shore part of the state has *E. nigrum* (Butters and Abbe 1953; Lakela 1965). Michigan has populations on Isle Royale, Keweenaw Peninsula, and the southeast shore of Lake Superior (Soper and Voss 1964). In the area of the Ontario north shore of Lake Superior, many collections and records have been made indicating presence of *E. nigrum* on many of the islands and many mainland locations as well. Soper and Voss (1964) list collections on the eastern shore of the lake, but besides these records there are at least 15 collections in the University of Toronto Herbarium, made by T. M. C. Taylor in the area from Michipicoten Island to the Slate Islands to Thunder Bay. C. E. Garton has four collections in the Lakehead University Herbarium, all from the Nipigon Bay – Thunder Bay region. In addition to these records the present study located stands at Bowman Island, Paradise Island, Owl Island, Thompson Island, and Victoria Island (for the distribution in the Bowman Island area see Figure 1). The Victoria Island record is the most southerly Ontario record on the northwest coast of Lake Superior.

Rather little information is available on the ecology of North American populations of *E.*

nigrum. There is, however, considerably more information dealing with west European populations. It should be noted here that this paper is dealing with *E. nigrum* in the broadest sense, as there is no general agreement on the systematics of *E. nigrum* populations. These taxonomic aspects have been discussed by Butters and Abbe (1953), Hultén (1968), and in detail by Löve (1960). Soper (personal communication to D.V.N., 1971), however, states that the designation, *E. nigrum* L., is being at least temporarily retained for all North American collections, and recent publications such as those by Boivin (1967), and Hitchcock and Cronquist (1961) use this appellation. In any case it is unlikely that more than one taxon, at the species level, is present on the north shore of Lake Superior. If Löve's (1960) key is used, the plants on Bowman Island, where the present ecological studies were carried out, are *E. eamesii* Fern. and Wieg. ssp. *hermaphroditum* (Hagerup) D. Löve. The plants are hermaphroditic with stamens being persistent on the mature fruit.

General aspects of the ecology of *E. nigrum* in western Europe have been described by Gimingham (1972). Its ecological amplitude is large; *E. nigrum* is a component of communities ranging from 'Mountain' to 'Wet' and 'Dry' lowland heaths. Soil moisture conditions tolerated by crowberry vary from well-drained sandy soils to wet peat soils. The peats are acid, while the sandy soils are usually acid-fixed dunes, as *E. nigrum* is a calcifuge species. In western Europe it is usually associated with open habitats, thought to be because germination is favored by light. Once established, *E. nigrum* can persist even under relatively low light conditions. During the vegetation cycle dominated by *Calluna vulgaris, E. nigrum* can become very prominent in the degenerate and pioneer phases, becoming much reduced in the light-excluding building and mature phases, and responding to this competition by change from a mat-like form to a rambling vine-like habit (Barclay-Estrup and Gimingham 1969).

In North America most records have rather brief habitat descriptions, but three types of habitats are prevalent. *Empetrum nigrum* is found in open peat bogs in northern Ontario (Soper and Voss 1964) and on Vancouver Island; it is found in moist coniferous forests, especially associated with black spruce, in Manitoba (Scoggan 1957) and in Alberta (Moss 1959). The third type of habitat is open sandy or rocky areas often associated with shorelines (Butters and Abbe 1953; Scoggan 1957; Soper and Voss 1964; Maini 1966). This third habitat type, open-rocky-or-sandy type, is of interest because it is found from Lake Superior to the Arctic tundra of the Northwest Territories. Maini (1966) describes communities from the boreal forest – tundra ecotone of the Northwest Territories, in which *E. nigrum* is found in closed-canopy black spruce stands, semi-open parkland, and treeless areas. *Empetrum nigrum* increases towards the drier and more open habitats, reaching its maximum cover in treeless areas of the boreal forest – tundra ecotone.

In the Lake Superior part of *E. nigrum*'s range, few habitat references are available. Butters and Abbe (1953) state that *E. nigrum* may be found ". . . growing on the bare rock of the smaller points extending out into Lake Superior and on the nearby ledges which often are wave-swept [and] are notably under the immediate influence of the low temperature of the lake water." Soper and Voss (1964) report a greater variety of habitats, such as rocky shores just above the water line reached during heavy storms; at slightly inland sites in bogs or muskegs; white cedar or black spruce bogs; on moist sandy banks; and even on a cliff of barren dolomitic sandstone. The present study is the first to deal with the general ecology of a population of *E. nigrum* on the shores of Lake Superior.

Study Area

Bowman Island is located just south of St. Ignace Island 39 kilometers southeast of Nipigon, Ontario at 48°44′ N and 87°59′ W (for specific details of description, location, and access, see Nuttall (1971) and Figure 1). The island is 4 kilometers long and 0.4 to 0.8 kilometers wide. The southern half is low-lying, being less than 10 meters above the lake level (lake level is 184 meters above sea level); the northern half of the island is higher, with a rock outcrop reaching an elevation of 35 meters.

Geologically the island is young, 9,400 to 10,000 B.P. (Before Present), and at least in part is a result of rebound following deglaciation (J. Franklin, personal communication to D.V.N., 1971). A few hard rock outcroppings of red quartz porphyry are present, but most of the island is made up of raised gravel beaches built up by wave

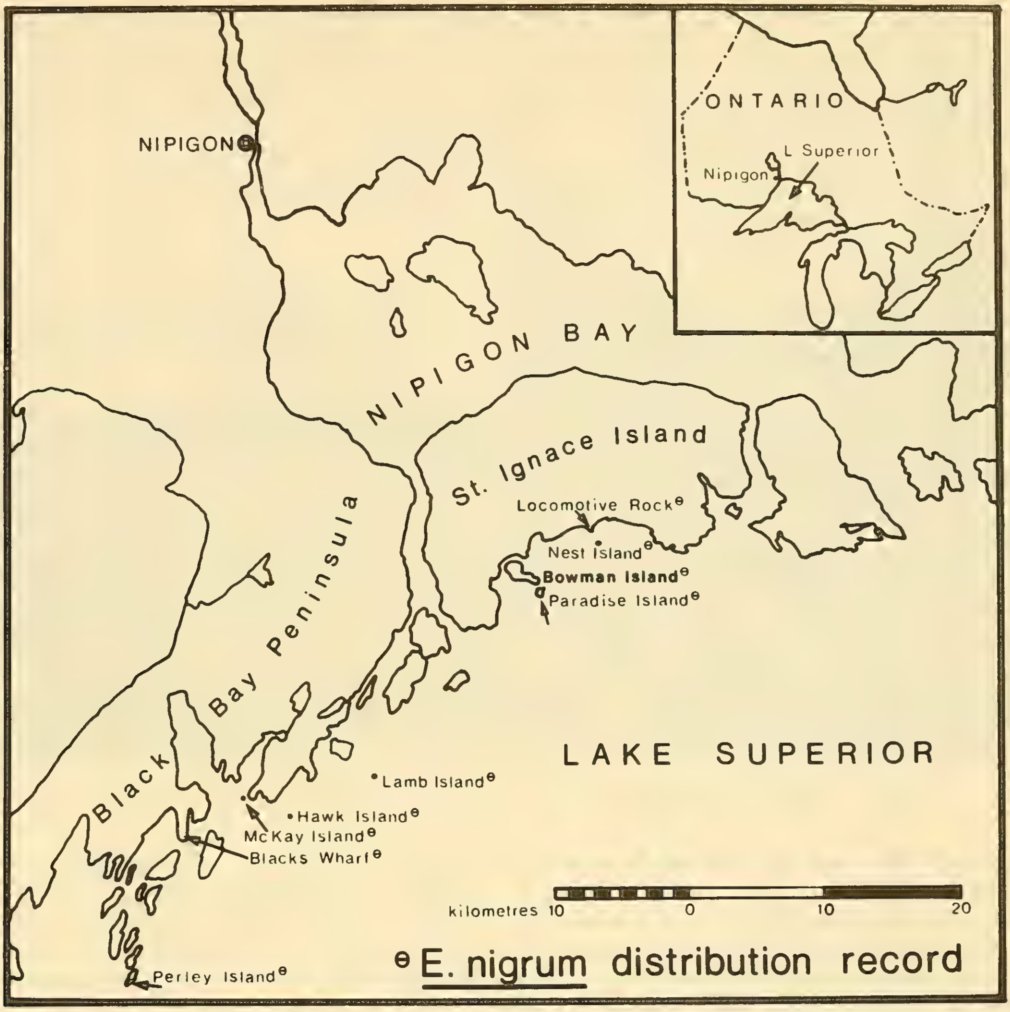

FIGURE 1. Location of Bowman Island and the distribution of *E. nigrum* in the adjacent area. Orientation of the vertical margins is north and south with north at the top.

action during the glacial rebound period. The gravel is locally derived from volcanic rocks by weathering. Little breakdown of the gravel has taken place and the soil between gravel fragments is almost completely organic. Gravel areas near the shoreline are subject to change from wave action, and alterations periodically take place.

Besides causing topographic alteration, the lake is perhaps more important in its effect on climate. In areas near to the lake, there is a very obvious climatic alteration in temperature, air movement, and probably also in humidity. There are no data for the climatic factors for the study area. The present study, however, does add some information in this regard.

Vegetation on the island is in two main community types. In mid-island (north–south orientation) and on the southeast shore at low elevation is a krummholz-lichen heath type (Figure 2). In this community *Picea mariana, Abies balsamea, Betula papyrifera,* and *Pyrus decora* grow in shrubby stunted form as islands in the lichen heath, which is dominated by *Cladonia* spp. and dwarf shrubs. The other community type is a mature black spruce – balsam fir forest in which the forest floor is dominated by two feather

FIGURE 2. Southeast shore of Bowman Island, Lake Superior, showing krummholz and lichen heath.

mosses, *Pleurozium schreberi* and *Ptilium crista-castrensis*.

Bowman Island is remote and access is difficult. Little alteration of the vegetation is apparent except in a small area near an old fish camp at the south end of the island. The forest has not been logged and there is little, if any, apparent alteration in the krummholz-heath areas. The vegetation may be slightly affected by biota such as red squirrel and snowshore hare, which are common, and a few white-tailed deer which are seen every year. Woodland caribou, once common on these islands, are now completely absent, and so this important lichen-grazing animal no longer affects the system. Grouse are known to feed on *E. nigrum* (Gimingham 1972) but these birds were not observed and at best are rare on the island.

When all factors are considered, the flora of the island is quite varied. A collection of all vascular plants on the island was made. The following list of sixty-nine species is a result of this collection (nomenclature is according to Fernald (1950) and Lakela (1965)): *Lycopodium annotinum*, *L. complanatum*, *Selaginella selaginoides*, *Abies balsamea*, *Picea mariana*, *Agropyron cristatum*, *Agrostis scabra*, *Calamagrostis canadensis*, *Danthonia spicata*, *Deschampsia caespitosa*, *D. flexuosa*, *Festuca saximontana*, *Phleum pratense*, *Poa pratensis*, *Trisetum spicatum*, *Carex* sp., *Scirpus caespitosus*, *Goodyera repens*, *Alnus crispa*, *Betula papyrifera*, *Urtica procera*, *Geocaulon lividum*, *Polygonum viviparum*, *Rumex acetosella*, *Lychnis chalcedonica*, *Sagina nodosa*, *Actaea rubra*, *Ranunculus acris*, *R. septentrionalis*, *Arabis lyrata*, *Ribes oxyacanthoides*, *Amelanchier huronensis*, *Fragaria virginiana*, *Geum allepicum*, *Rubus* sp., *Physocarpus opulifolius*, *Potentilla norvegica*, *P. tridentata*, *Prunus pensylvanica*, *Pyrus decora*, *Rosa acicularis*, *Lathyrus japonicus*, *Empetrum nigrum*, *Viola adunca*, *Epilobium angustifolium*, *Heracleum lanatum*, *H. maximum*, *Cornus canadensis*, *Moneses uniflora*, *Monotropa uniflora*, *Pyrola secunda*, *Arctostaphylos uva-ursi*, *Ledum groen-*

landicum, Vaccinium angustifolium, V. myrtilloides, V. vitis-idaea, Primula mistassinica, Trientalis borealis, Galeopsis tetrahit, Euphrasia hudsoniana, Melampyrum lineare, Linnaea borealis, Sambucus pubens, Viburnum edule, Campanula rotundifolia, Achillea lanulosa, Chrysanthemum leucanthemum, Hieracium canadense, Solidago randii, Taraxacum officinale.

Methods

All studies were carried out in the krummholz-lichen heath and adjoining forest on the southeastern shore of Bowman Island. Three quadrat areas were used. These were selected on the basis of the presence of *E. nigrum*. The largest area is 25×12 meters, the second is 15×6 meters, and the third 5×2 meters. The first two areas contain all three vegetation types (forest, krummholz islands, and lichen – dwarf shrub heath). The last and smallest area is in the forest. In each case the longer dimension runs at right angles to the lake shore and is used as a baseline. Sample quadrats were selected using random number tables with 20 in the first area, 6 in the second, and 1 in the third. Each sample quadrat is 1 meter in length.

These 1-meter quadrat areas were used first as line transects for a presence (frequency) study, and secondly as the base for biomass samples. In the presence study done in June 1970, overhanging trees and all species touching one side of a meter stick were recorded. The biomass samples (above ground level), were taken in September 1970 and all lichens, bryophytes, and vascular plants in quadrats 100 × 25 centimeters were collected, oven-dried at 105°C, and weighed.

Annual tip growth of *E. nigrum* was measured by selecting, at random, 50 tips from each of the three areas (Forest, Krummholz, and Heath). These samples were collected in September and both 1970 and 1969 growth rates were measured.

Temperature measurements were made for the period 27 May to 9 September 1970. A set of (maximum and minimum) grass thermometers were placed in a mat of *E. nigrum* at the edge of a Krummholz area. A Sixes maximum-minimum thermometer was placed at ground level at the base of a Krummholz-type black spruce. A second Sixes thermometer was placed in the Forest on a black spruce at 1-meter height. All were well shaded and there was no direct insolation.

Twenty-seven soil samples were taken from the sample quadrat areas after the biomass samples were made. Because of the large amounts of gravel present the standard soil core method could not be used. Samples were taken as four sub-samples, 10×10×10 centimeters, in each quadrat and the gravel was discarded. Most of the soil was present as a thin layer, 1 to 2 centimeters on the top of the gravel rocks. The samples were taken to the laboratory and air-dried. In December 1970 all samples were tested for pH, loss-on-ignition (carbon content), and moisture-retaining capacity. The methods used for pH and loss-on-ignition are outlined by Atkinson et al. (1958); the method used for water-retaining capacity is outlined by Curtis and Cottam (1962).

Results

Bowman Island is in the Superior section of the Boreal Forest Region (Rowe 1972), and the phytogeographic floristic affinities are primarily boreal. There is also present a group of plants that have arctic, alpine, and subarctic distributions. Examination of the list of vascular plants found on Bowman Island (see list on pp. 7–8), using the criteria of Porsild (1964) and Soper and Maycock (1963), shows 12 species to be of this arctic, alpine, and subarctic group. These species are as follows: *Deschampsia caespitosa, Trisetum spicatum, Scirpus caespitosus, Polygonum viviparum, Sagina nodosa, Potentilla tridentata, Empetrum nigrum, Vaccinium vitis-idaea, Euphrasia hudsoniana, Campanula rotundifolia.* Of this group of plants only three, *Empetrum nigrum, Vaccinium vitis-idaea,* and *Potentilla tridentata,* were encountered in the sample quadrats on the exposed shoreline of Bowman Island.

The presence (frequency) studies of the quadrat areas show three main communities: Forest, Krummholz islands, and Heath. Twenty-eight species of plants were found in the sample areas; this list includes vascular plants, bryophytes, and fruticose and foliose lichens. Fourteen species were found in the Forest, 17 in the Krummholz, and 18 in the Heath. When Sorensen's coefficient of similarity (Greig-Smith 1964) is applied to the data, the results are as follows: Forest–Krummholz C = 64.5, Forest–Heath C = 43.8, Krummholz–Heath C = 62.9.

Further in the presence studies, if the species are divided into four categories (i.e., trees,

shrubs–herbs, mosses, and lichens), percents of the total presence may be taken for each community type (Table 1).

Figure 3 shows presence relationships of individual species in the three community types, arranged in four categories. To conclude the presence study, Figure 4B shows the performance of categories and species in each of the three community types.

TABLE 1 — Percentage presence for each community type in the sample plots

Species category	Forest, %	Krummholz, %	Heath, %
Trees	14.6	16.7	10.3
Shrubs–herbs	41.5	43.8	30.7
Mosses	43.9	26.0	7.7
Lichens	0.0	13.5	51.3

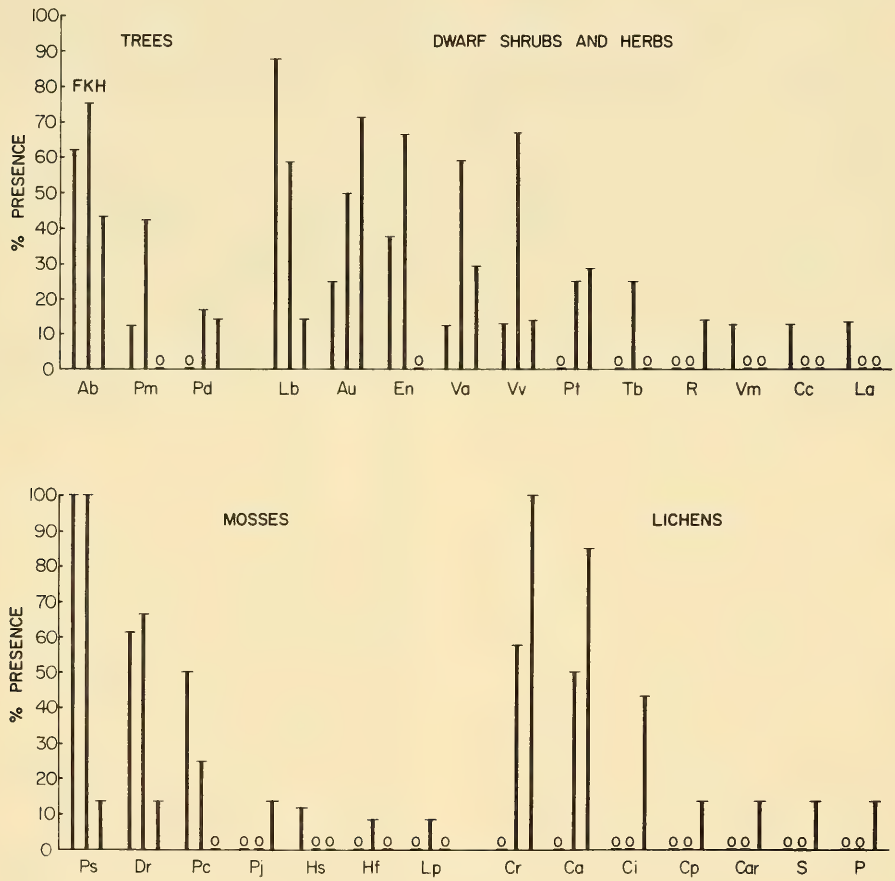

FIGURE 3. Presence study of Bowman Island quadrats showing performance of individual species in each community type. In each group of three lines the order is (1) Forest (F), (2) Krummholz (K), (3) Heath (H). 0 Indicates no record. Species are arranged in order of total performance in each vegetation category (i.e., Lb has a greater total performance than does Au). Symbols for species are as follows: Ab *Abies balsamea*, Au *Arctostaphylos uva-ursi*, Ca *Cladonia alpestris*, Car *C. arbuscula*, ' ’s *Cornus canadensis*, Ci *Cetraria islandica*, Cp *Cladonia pyxidata*, Cr *C. rangiferina*, Dr *Dicranum rugosum*, En *Empetrum nigrum*, Hf *Hypnum fertile*, Hs *Hylocomium splendens*, La *Lycopodium annotinum*, Lb *Linnaea borealis*, Lp *Leskea polycarpa*, P *Parmelia* sp., Pc *Ptilium crista-castrensis*, Pd *Pyrus decora*, Pj *Polytrichum juniperinum*, Pm *Picea mariana*, Ps *Pleurozium schreberi*, Pt *Potentilla tridentata*, R *Rubus* sp., S *Stereocaulon* sp., Tb *Trientalis borealis*, Va *Vaccinium angustifolium*, Vm *V. myrtilloides*, Vv *V. vitis-idaea*.

The results of the biomass samples are shown in kilograms per square hectare in Figure 4A. Total biomass for each community type is as follows: Forest 2006.4 kg ha^{-1}, Krummholz 2006.0 kg ha^{-1}, and Heath 3811.2 kg ha^{-1}. In the Forest type *E. nigrum* at 169.2 kg ha^{-1} constitutes 68% of the vascular total and 8% of the total biomass. In the Krummholz type it is 61% of the vascular total and 15% of the total biomass.

Annual mean tip-growth in *E. nigrum* for 1969 and 1970 is 4.7 centimeters for the Forest type, 4.7 centimeters for the Krummholz, and 5.1 centimeters for the open Heath (Krummholz–Heath ecotone). The mean for all areas is 4.8 centimeters.

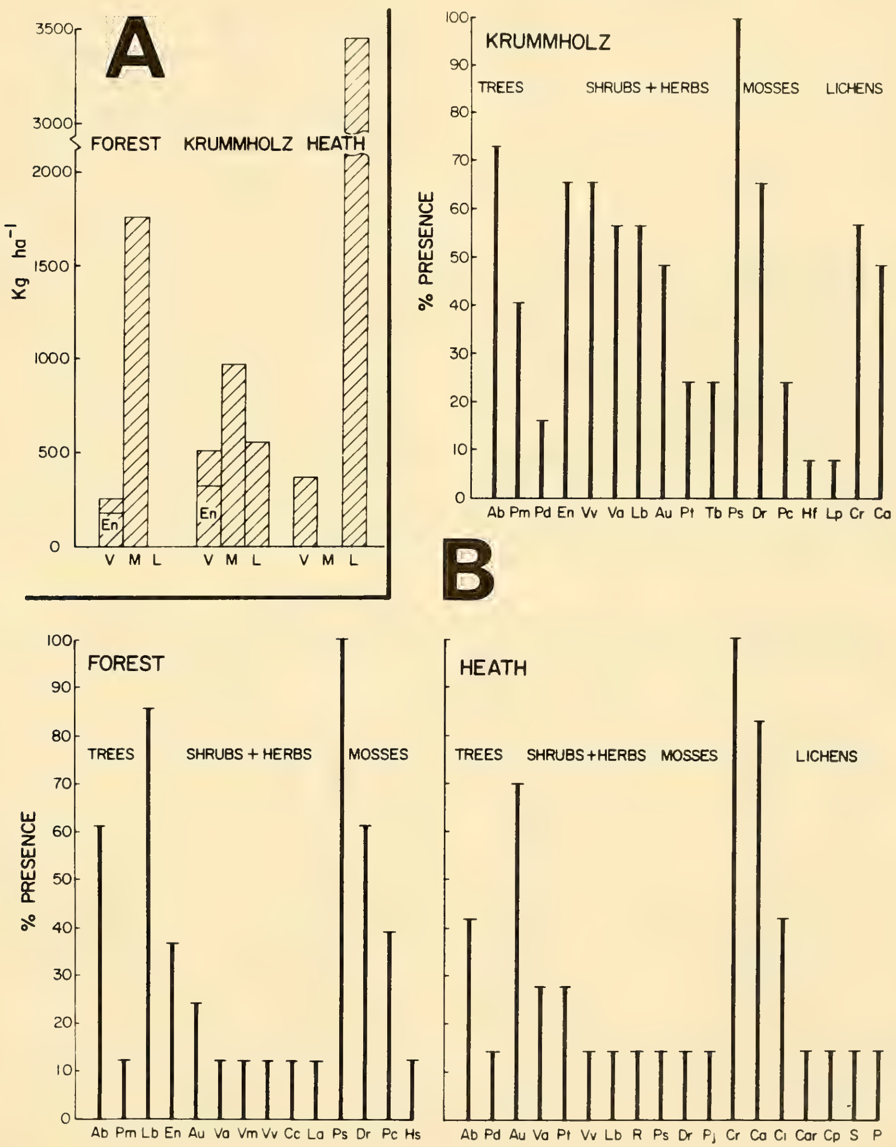

FIGURE 4. A. Biomass totals for sample quadrats on Bowman Island showing each community type. Symbols are as follows: V vascular plants (other than trees), M mosses, L lichens, En biomass of *Empetrum nigrum*. B. Presence study showing performance of species in each community type. All species symbols are as in Figure 2.

The soil samples show that gravel is the major constituent of the soil. In Table 2 are shown measurements of the organic fraction found between the gravel fragments.

TABLE 2 — Soil characteristics for each community type in the sample plots

Community type	pH	Water-retaining capacity, %	Loss-on-ignition, %
Forest	4.5	747	88.5
Krummholz	4.9	627	85.9
Heath	4.7	512	88.2
Mean	4.7	627	87.5

The results of the temperature studies are shown in Table 3. The temperatures of the three areas on Bowman Island vary, and indicate that the Krummholz has the highest maximum temperatures and the Heath the lowest minimum temperatures, with the Forest being intermediate. Differences between the Bowman Island sites are not large, but if these sites are averaged and compared with those of the Lakehead International Airport, a significant difference is noted. The mean maximum for the island is 22.4°C compared to 30.7°C at the Lakehead, and the mean minimum is 3.6°C at the island and 5.1°C at the Lakehead.

Discussion

Empetrum nigrum is considered to be an arctic-alpine plant, and its presence on Bowman Island indicates unusual conditions for the latitude and elevation of the area under consideration. The vascular flora, however, does not indicate a true arctic-alpine designation. While 12 species are arctic-alpine, these constitute only 17% of the vascular flora, and only two of these species were found in the krummholz–lichen heath area investigated. The physiognomy is, notwithstanding, very reminiscent of alpine and forest-tundra vegetation.

There are three communities in the area studied and each has a different microclimate. Light increases from Forest to Krummholz to Heath. Air movement increases along the same gradient. Temperature is highest in the Krummholz where insolation is high and air movement is restricted. The Forest, with restricted light and air movement, is intermediate, while the Heath is the coolest community in spite of high insolation, as direct access by the very cool air from the adjacent lake keeps temperatures low. The Bowman Island temperatures are significantly lower than those

TABLE 3 — Temperature (degrees Centigrade) for three areas on Bowman Island and for Lakehead International Airport for the period 27 May to 9 September 1970. Dashes are for periods when the island was inaccessible because of adverse weather conditions.

		Forest		Krummholz		Heath		Lakehead	
Date	1970	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
June	3	20.0	−1.7	21.1	−2.8	21.7	—	21.7	−1.7
	10	24.4	3.3	26.1	2.8	19.4	0.6	33.9	6.1
	17	15.6	3.3	17.8	2.2	16.1	0.0	31.7	5.6
	24	18.9	1.7	21.1	0.6	17.8	1.1	26.7	1.7
July	1	—	—	—	—	—	—	—	—
	8	26.1	3.9	30.0	3.3	20.0	−0.6	32.2	5.6
	15	22.2	7.2	25.6	6.1	21.1	5.6	30.0	8.9
	22	—	—	—	—	—	—	—	—
	29	27.2	7.2	27.2	5.6	23.9	3.9	33.3	6.1
August	5	24.4	8.3	24.4	6.7	18.3	3.9	32.2	4.4
	12	23.9	8.9	26.1	7.8	20.0	5.6	30.6	11.7
	19	—	—	—	—	—	—	—	—
	26	—	—	—	—	—	—	—	—
Sept.	2	—	—	—	—	—	—	—	—
	9	24.4	6.1	26.1	3.3	21.7	2.8	34.4	2.2
Mean		22.7	4.8	24.6	3.6	20.1	2.7	30.7	5.1

recorded at Lakehead International Airport, which is 17 kilometers from Lake Superior. These climatic data are scant, and a much more critical study is required to elucidate the special conditions found on Bowman and nearby islands. Humidity is probably very significant and no data are as yet available for this factor. Temperature itself is unlikely to be a limiting factor for *E. nigrum,* as its great latitudinal and altitudinal distribution preclude such a conclusion, and the data from Bowman Island indicate that *E. nigrum* is least common in the coolest area, that of the Heath.

The soil data for the three communities indicate very similar soil conditions in all three areas. The soils are acid, high in organic content, and have a high water-retaining capacity. When the large gravel fraction (greater than 90%) is included, the soils must be considered to be very well drained and potentially very dry. Water loss, however, must be markedly reduced in the Forest and Krummholz by higher humidities, reduced insolation, reduced air movement, and the restricting effect of the vegetation layer. In the Heath, water loss is reduced by the presence of the *Cladonia*-lichen mat (Kershaw and Rouse 1971). As *E. nigrum* is found in quantity in both the Forest and Krummholz, the soil conditions of these areas satisfy soil requirements, and the soil conditions of the Heath are not limiting, at least in the parameters investigated.

The presence study shows the three community types to be distinct. This is readily observable in the field, with narrow transition zones of 30 centimeters or even less in some cases. The Krummholz is intermediate between the Forest and the Heath. This intermediate position is shown by the relative values of species in the four groups: trees, shrubs-herbs, mosses, lichens. The mosses and lichens are especially useful in this regard: Forest—no lichens, mosses common; Krummholz—mosses and lichens; Heath—lichens common, few mosses. The coefficients of similarity bear out the intermediate position of the Krummholz.

When the performance of individual species is examined a definite habitat preference is exhibited between community types. The "trees" category indicates a preference for Krummholz, but this is partly a function of the sample size used, as the trees are closer together in the Krummholz than they are in the Forest. A different sample size would be needed for a more accurate representation of this category. In the other categories sample size is satisfactory and species performances are readily observable; for example, *Linnaea borealis* increases from Heath to Krummholz to Forest, and *Arctostaphylos uva-ursi* does just the opposite. *Vaccinium vitis-idaea* is best suited to the conditions of Krummholz but is represented in Forest and Heath as well. *Empetrum nigrum* is absent from the Heath but common in Forest and Krummholz, with its best performance being in the latter. All the mosses are most common in Forest or Krummholz except *Polytrichum juniperinum*, which is found only in the Heath. The lichens are well suited to the conditions of the Heath and some are also found in the Krummholz, but are absent from the low light conditions of the Forest.

The biomass study indicates relationships similar to those shown in the presence study. The figures for total biomass of each of the three community types indicate that the Heath has almost twice the biomass of either the Krummholz or the Forest. Again, sampling method must be considered, as the sample does not include the tree layer. Therefore, while the total biomass is being sampled in the case of the Heath, in the other two community types only part of the total biomass is represented. The total for the Heath is less than Whittaker's (1970) world mean of 6000 kg ha^{-1} but easily falls within the normal range of 1000 to 70,000 kg ha^{-1}. *Empetrum nigrum* is the major constituent of the vascular plant (other than trees) contribution to biomass in both Forest and Krummholz, and while its percent contribution is about equal in both cases, it is in the Krummholz that *E. nigrum* reaches its greatest biomass.

Tip growth of *E. nigrum* is, unlike biomass, very uniform for the three areas sampled, but many more tips are produced per unit area in the open Krummholz than in the Forest. So while mean tip growth is rather similar, net productivity is not. Comparison of the Bowman Island growth rate with measurements made in a Scottish heath (Barclay-Estrup 1966) again shows means to be rather similar —Bowman Island 4.8 centimeters and Scotland 4.2 centimeters. But in the Scottish heath there is a significant difference in growth rates in different habitats, varying from 5.3 in rather shaded mature-phase habitat to 2.8 in the more open degenerate-phase habitats.

According to Gimingham (1972), *E. nigrum* may form a component, in western Europe, of various seral stages, from acting as an invader of dune systems to belonging to woodland communities, and it is also present in seres and cyclical processes in northern Manitoba (Ritchie 1959). *Empetrum nigrum* plays a role in at least two distinct cyclical processes in Britain. It is a component of the dwarf-shrub flora in the cycle dominated by *Calluna vulgaris* (Barclay-Estrup and Gimingham 1969) and in an alpine cycle dominated by *Rhacomitrium lanuginosum* (Watt 1947). A third cyclical process is described by Maini (1966) in the Northwest Territories. In this instance *E. nigrum* dominates the cycle which is strongly influenced by permafrost.

Vegetation dynamics are also taking place on Bowman Island. No immediately obvious cycles were observed and no regeneration by seed was noted. Further studies could possibly reveal a cycle, and if so the cycle could be of the *Calluna* type, where some other plant acts as the dominant and *E. nigrum* is a component of the associated vegetation.

A succession, probably similar to that described by Ritchie (1959) in northern Manitoba, appears to be taking place on Bowman Island, and *E. nigrum* is a part of at least two stages in that succession. The hypothesized stages of the succession are these: (1) a primary bare area of gravel formed into a terrace by wave action, (2) lichen heath beginning with crustose lichens and culminating in a mixed fruticose-foliose lichen dwarf-shrub community, (3) Krummholz island probably initiated by white birch and/or *Vaccinium* spp. and eventually dominated by balsam fir and black spruce, (4) a final stable stage of a balsam fir – black spruce feather moss forest.

The succession could be naturally interrupted in two ways. First, fire could return any stage to some earlier stage. *Empetrum nigrum* is a fire-tolerant species and would survive most fires. The other factor affecting vegetation near the shore (such as the area studied) is wave action. Severe wave action occurs periodically along the Superior shore. In November 1971 wave action scoured the vegetation from rocks more than 10 meters above the water line at Porphyry Point Lighthouse, 60 kilometers southwest of Bowman Island. This type of wave action could create primary bare areas, initiating a new succession.

In any case, *E. nigrum* is an integral part of the conifer forest vegetation on Bowman Island and should remain a permanent part of that vegetation and also of Krummholz communities when the habitat is available.

Acknowledgments

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An Intergeneric Grouse Hybrid (*Bonasa* × *Canachites*)

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Ouellet, Henri. 1974. An intergeneric grouse hybrid (*Bonasa* × *Canachites*). Canadian Field-Naturalist 88: 183–186.

Abstract. The first known hybrid between *Canachites canadensis* × *Bonasa umbellus* is described from a tail fan and the left wing of a specimen shot at Lac Brown, Champlain County, Quebec, on 24 October 1971. A detailed description of the parts, drawings of primaries, and relevant measurements are provided. Finally, the origin of the hybrid is discussed.

Résumé. Ce travail porte sur le premier cas connu d'hybridation entre *Canachites canadensis* × *Bonasa umbellus*. La description de l'hybride est fondée sur la queue et l'aile gauche d'un spécimen capturé au lac Brown, comté de Champlain, Québec, le 24 octobre 1971. Apparaissent une description détailée de ces parties, des dessins des primaires et des mensurations pertinentes. Enfin, on commente l'origine de l'hybride.

Introduction

Several intergeneric grouse hybrids have been reported in the literature (Cockrum 1952; Gray 1958; Stüwe 1971) but no hybrid of *Bonasa umbellus* × *Canachites canadensis* appears to have been described to date (Johnsgard 1973). In conjunction with a population study of the Ruffed Grouse in Quebec, a large sample of wings and tail fans was collected from hunters' bags in Quebec provincial game reserves during the fall of 1971 by personnel of Service de la Faune du Québec.

An unusually marked tail fan and left wing, taken from an unidentified grouse specimen (weight: 595.3 g), were sent to me for determination. The rest of the body was, unfortunately, not preserved. The bird had been shot at Lac Brown, Champlain County (46°55′ N, 73°10′ W), on 24 October 1971 (No. 707, Service de la Faune du Québec ornithological collection). I identified these parts as those from a hybrid between the Spruce Grouse (*Canachites canadensis*) and the Ruffed Grouse (*Bonasa umbellus*) on the basis of the characters described below.

Description

Wing

The wing resembles superficially that of *C. canadensis* (Figure 1), although certain feathers are like those of *B. umbellus*. The 10th (outermost) primary has a plain outer vane as in *C. canadensis*. Primaries 9, 8, 7, 6, and 5 bear inconspicuous vermiculations on the distal part of the vane not unlike those of *C. canadensis*, although these feathers are slightly brighter. The vermiculated pattern at the end of the inner vane is similar to that of *B. umbellus* but the size of the vermiculated area is more restricted. The other primaries (4, 3, 2, and 1) are similar to those of *C. canadensis*, although the vermiculation of the tip is slightly more extensive and brighter than in *B. umbellus*. The inner vane of primaries 3, 2, and 1 is speckled with light markings as in *B. umbellus*.

The outer secondaries resemble closely those of *C. canadensis* but the markings at the border of the outer edge are slightly wider and coarser than those found in that species. The inner vane bears vermiculations somewhat less conspicuous and more restricted than in *B. umbellus*. The inner secondaries exhibit near the end, on the upper surface, a pattern which closely resembles that found in *B. umbellus* (Figure 1).

The alula and its coverts are similar to those of *C. canadensis*, although they are slightly vermiculated with russet on the outer vane as in *B. umbellus*, but the rachis is similar in coloration to the rest of the feather.

The wing coverts are intermediate in coloration and pattern between those of the two species, being marked with reddish brown and grayish brown, but bear a narrow lanceolate mark on the rachis not unlike that found in a similar position on *B. umbellus*.

The shape of primaries 10 and 8 (Figure 2) and the length of primary 10 (Table 1) are intermediate between those of the parent species. Short (1967) has shown the relevance of shape differences of the outer primaries in various grouse genera. It is significant to note that in the hybrid the shape of these two primaries (8 and 10) is intermediate between that of *B. umbellus* and *C. canadensis*.

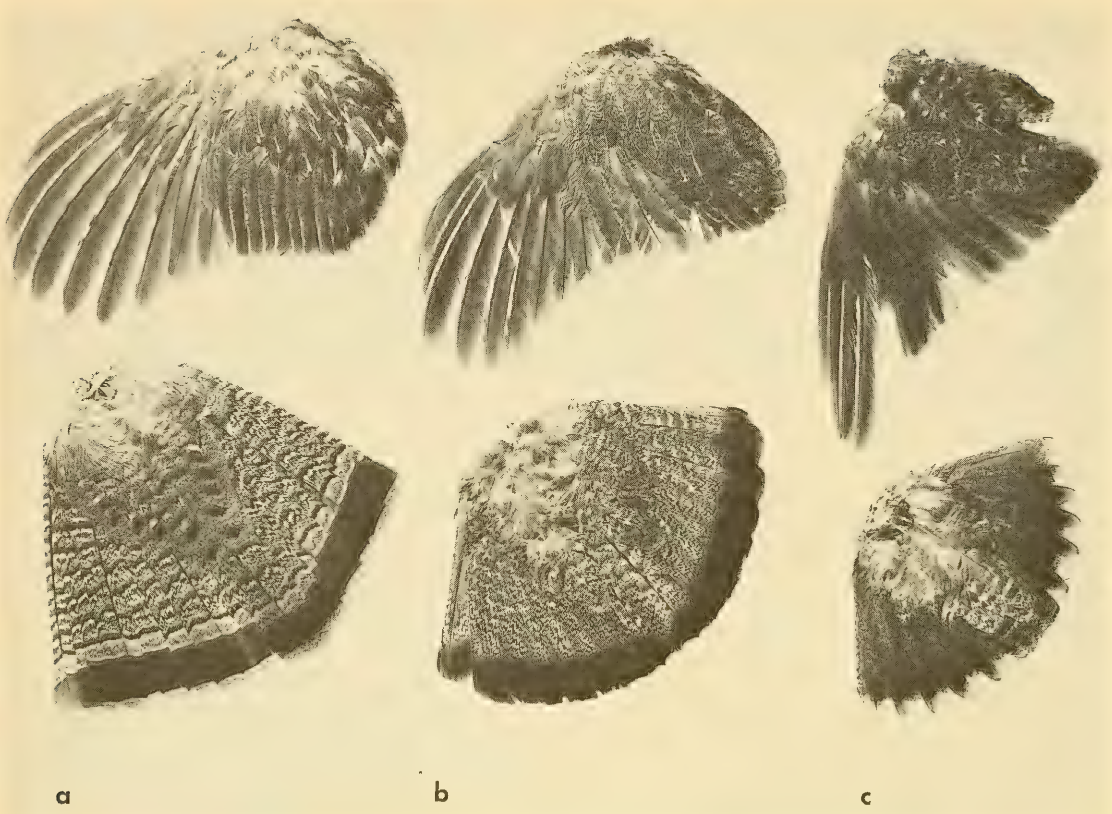

FIGURE 1. Wing and tail of (a) *Bonasa umbellus*, (b) hybrid, (c) *Canachites canadensis*.

The underwing closely resembles that of a male *C. canadensis* in both its pattern and general coloration. Several of the greater under secondary coverts, however, bear a close resemblance to those of *B. umbellus* in having an extensive white terminal marking. The lesser under secondary coverts bear more extensive white areas than those of *C. canadensis*, although their general coloration is much darker than that of *B. umbellus*.

TABLE 1 — Comparative measurements (in millimeters) of left wing 10th primary, central and external rectrices of males and females of *Bonasa umbellus*, *Canachites canadensis*, and hybrid

		Bonasa umbellus		*Canachites canadensis*		
		Number	Mean	Number	Mean	Hybrid
10th primary	♂♂	24	99.5	16	86.8	94.3
	♀♀	22	98.5	24	85.2	
Central rectrix	♂♂	24	153.6	24	115.6	126.5
	♀♀	25	131.7	19	100.1	
External rectrix	♂♂	24	147.7	24	103.2	114.9
	♀♀	25	129.4	22	91.4	

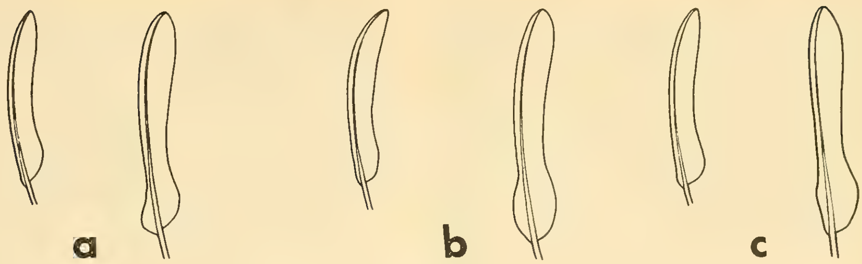

FIGURE 2. Primaries Number 10 and Number 8 of (a) *Bonasa umbellus*, (b) hybrid, (c) *Canadhites canadensis*. Shape of lower part is of particular significance.

Tail

Short (1967, p. 8) found that the usual number of rectrices is 18 in *B. umbellus* and 16 in *C. canadensis*. The hybrid has 18 rectrices. My examination of 50 specimens of each species (Table 2) provided results comparable to those obtained by Short (1967, p. 8) on the number of rectrices and frequency of distribution. The arrangement of the rectrices and upper tail coverts in the specimens examined is similar to pattern No. 7 provided by Short (1967, p. 6) for the genus *Dendragapus* (= *Canachites*). The length of the central and external rectrices of the hybrid lies between the means of similar measurements for *B. umbellus* and *C. canadensis* (Table 1).

As shown in Figure 1, the upper surface of the tail of the hybrid is very different from that of *B. umbellus* and *C. canadensis,* and is rather nondescript, except for a broad black terminal bar and heavy general vermiculation. All the rectrices are tipped with a varying amount of gray, without any trace of brown, reddish brown, or white. The under-surface of the rectrices has a similar appearance but the under tail coverts resemble more closely those of a female *C. canadensis,* although they are somewhat browner.

TABLE 2 — Number of rectrices in two species of grouse of eastern Canada

Number of retrices	*Canachites canadensis*	*Bonasa umbellus*
15	5	0
16	45	1
17	0	2
18	0	45
19	0	1
20	0	1
Total specimens examined	50	50

Discussion

The Spruce Grouse and the Ruffed Grouse are sympatric over vast areas across their range in North America (A.O.U. Check-list 1957; Godfrey 1966; Johnsgard 1973). They are well distributed within their range and vary in numbers from rare to abundant, depending on local conditions and population levels. Their habitats, at least in the general area where the hybrid was taken, are usually well separated. The Spruce Grouse occurs mainly in mature coniferous stands whereas the Ruffed Grouse prefers second-growth areas, alder thickets, and deciduous stands; it is less frequently found in the coniferous forest, except when second-growth stands are found within it or nearby.

The courtship behavior and displays of the Spruce Grouse (MacDonald 1968; Lumsden 1961) are different from that of the Ruffed Grouse (Hjorth 1970). Lumsden (1969) indicates that the Spruce Grouse is polygamous and that it has no pair bond. He describes briefly the propensity of males to attempt copulation with study skins or damaged specimens (Lumsden 1961, p. 25). This behavior suggests that mating could take place with a female of another species provided that such a female is receptive and assumes a stimulating posture in the presence of a male, even from another species.

The Ruffed Grouse appears to be promiscuous as well (Hjorth 1970) although it is probably so to a lesser extent than the Spruce Grouse.

Current classifications (Ridgway and Friedmann 1946; A.O.U. Check-list 1957), and Short (1967) in a recent review of grouse taxonomy, recognize

close relationships between the various tetraonid genera, but *Bonasa* and *Canachites* (= *Dendragapus, sensu* Short 1967) are generally considered divergent from each other, although they probably arose from a common pre-*Dendragapus* stock. I feel that the present instance of intergeneric hybridization suggests a closer relationship between the genera involved than it has been realized to date.

One can only speculate on the origin of this hybrid. It appears that hybridization became possible after the breakdown of one of the isolating mechanisms. In this instance, intensive logging-operations have taken place in the area of origin of the hybrid over a period of several years. Coniferous stands have thus become rare and isolated in the region, whereas second-growth and deciduous stands now form the dominant vegetation types. Under these circumstances it is likely that the Spruce Grouse population had to withstand heavy pressures, whereas the Ruffed Grouse population has thrived as it can be expected in a similar situation.

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Use of Highway Overpass Embankments by the Woodchuck, *Marmota monax*

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Doucet, G. Jean, J.-P. Raymond Sarrazin, and J. Roger Bider. 1974. Use of highway overpass embankments by the woodchuck, *Marmota monax*. Canadian Field-Naturalist 88: 187–190.

Abstract. During the springs of 1971, 1972, and 1973, woodchucks (*Marmota monax*) and burrows were counted on overpass embankments of two major highways. The number of burrows (768) observed for the three years indicated a high activity on embankments. Woodchuck abundance in embankments constituted a seasonal problem for maintenance crews; however, the possible safety hazard was dismissed. The food, substrate, and excellent drainage of the slopes supported a very high population of woodchucks (44.64 per 100 acres) despite serious traffic hazards and the presence of predators.

Introduction

In recent years, studies have been done on the ecological impact of roadways on various animal populations. Bellis and Graves (1971) and McCaffery (1973) analyzed deer mortality due to traffic. Klein (1971) reported that highways did not interfere greatly with the movement of reindeer in Scandinavia. Pienaar (1968) assessed the ecological significance of roadways in African parks, and Oetting (1971) reported on the habitat created by rights-of-ways.

Woodchuck activity on the embankments of one highway overpass led us to consider the possibility that intensive burrowing could create a twofold problem for maintenance crews. First, burrowing might lead to pavement caving and, therefore, could create a serious highway safety hazard; and second, the microtopography around the burrow entrances could make grass-cutting more time-consuming, and hazardous for the machinery.

A preliminary survey of woodchuck holes led us to believe that overpasses supported relatively high populations. That a high density of woodchucks should exist so close to high-speed highways seemed paradoxical. Thus, further investigation was warranted to determine the number of animals per acre, to identify some of the factors which make overpasses such good woodchuck habitat, and finally to determine by what means high populations of woodchucks survive adjacent to such potentially lethal roadbeds.

Methods

Burrows and woodchucks were counted on the embankments of 21 overpasses on four occasions during 1971, 1972, and 1973. The first five overpasses (Table 1) are situated between Ste-Anne-de-Bellevue and Rigaud, Québec, on the Trans-Canada Highway. The remaining 16 overpasses (6–21, Table 1) are situated between Dorion, Québec, and the Lancaster Interchange, Ontario, on the Macdonald-Cartier Freeway.

Counts were always made on warm, sunny days. The shortness of grass (mainly *Agropyron repens*) and other ground cover during May provided excellent ground visibility. The first two censuses (Table 1) were done on May 15 and 16, 1971, and May 1, 1972, as follows. The vehicle was stopped on each side of the overpasses to count holes and woodchucks, using field glasses from a distance. This enabled us to count the maximum number of woodchucks in the shortest possible time. Eleven woodchucks were observed in each census. During the first census, 91 burrows were observed, while only 40 were seen the next year. Although they were made at different times in May 1971 and 1972, the large discrepancy between censuses indicated that all burrows were not counted. To improve our count, two additional censuses were carried out on May 23 and 24, 1972, and May 15 and 16, 1973 (censuses 3 and 4, Table 1). During these censuses the embankments were scanned with the glasses, then searched thoroughly by two observers on foot to ensure that no holes were missed. Abandoned holes which appeared not to have been used in the current year were not counted.

In addition to burrows and woodchucks, observations were obtained on hole depths and position in relation to pavement, grass cutting and burning operations, proximity of water and buildings, compac-

TABLE 1 — Woodchuck abundance at highway overpasses

Overpass number	Census 1		Census 2		Census 3		Census 4	
	Burrows	Woodchucks	Burrows	Woodchucks	Burrows	Woodchucks	Burrows	Woodchucks
1	0	0	1	0	8	1	9	0
2	2	1	1	1	37	3	35	4
3	25	3	11	3	69	2	57	2
4	7	0	2	1	40	1	73	4
5	0	0	0	0	3	1	3	0
6	12	4	3	0	27	1	40	2
7	10	0	7	2	14	1	21	1
8	0	0	1	0	3	0	9	0
9	1	0	0	0	5	0	4	1
10	1	1	0	0	0	0	0	0
11	7	0	2	0	7	0	9	0
12	0	0	0	0	0	0	0	0
13	9	1	6	2	12	1	11	0
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	1	0	0	0	0	0	3	0
17	10	1	4	1	45	0	12	0
18	2	0	0	0	0	0	0	0
19	0	0	1	0	5	0	5	0
20	0	0	1	1	6	2	10	0
21	4	0	0	0	23	1	32	0
Totals	91	11	40	11	304	14	333	14
Minimum number of woodchucks		18		16		19		22
Number of woodchucks per 100 acres		42.86		38.09		45.24		52.38
Mean number of woodchucks per 100 acres			44.64					

tion, drainage and surface area of slopes, soil types, topography, landscaping, and interactions with other animals (foxes, coyotes, muskrats, dogs, cats).

Results

The highest numbers of woodchucks were observed in the third (14) and fourth (14) censuses. It is important to note that the time spent at each overpass during these latter censuses was considerably longer because the embankments were searched on foot, thus increasing the probability of seeing individuals. A burrowed overpass indicated that the embankments were inhabited by at least one woodchuck. Results (Table 1) showed that in mid-May 1971 (census 1), early and late May 1972 (censuses 2 and 3), and mid-May 1973 (census 4), there were, respectively 13, 12, 15, and 16 overpasses occupied. In each census, several overpasses contained more than one woodchuck. Thus in May 1971, early and late May 1972, and May 1973, there were, respectively, at least 18, 16, 19, and 22 woodchucks in the area sampled. Five woodchucks and one skunk found dead at the overpasses during the study were killed seemingly by cars.

Overpass embankments studied were usually built up with heavy rubble, then sand, and covered with top-soil. Soil samples from 21 overpasses revealed that woodchuck diggings were concentrated near the bottom of the slopes where the top-soil layer was thinner. This seemed to indicate a preference for sandy soil. At two heavily dug overpasses, however, all the holes were dug in clay. It is noteworthy that the area surrounding both overpasses was part of a large clay belt and woodchucks were probably accustomed to digging in clay. The

overpasses studied were essentially similar, with a standard highway clearance. The average surface area of four embankments was 72,000 square feet (2 acres), for a total sampled area of 42 acres. Results of the four censuses (Table 1) represent minimum populations of 42.86, 38.09. 45.24, and 52.38 woodchucks per 100 acres, with a mean of 44.64 for the 3 years.

There was no significant difference between the number of holes observed on southern and northern slopes. The thorough compaction of the top 3 feet of these modern overpasses seemed to inhibit woodchuck burrowing. The closest entrance to the paved surface, however, was 4 feet from the road and extended at least 5 feet under the pavement. No pavement depression was attributed to woodchuck burrowing either in this study or in other areas or at other times (Parent, Blouin, Poirier, personal communication). Den entrances reduced the efficiency of grass-mowing crews and created a menace for the equipment (Léger, personal communication).

The vegetation and slopes of the overpasses studied were very similar except for a few embankments in Ontario where the slopes were in two sections. A few pines had also been planted at these overpasses. Most overpasses supported very high populations of field voles, *Microtus pennsylvanicus*. Large dogs, cats, and hawks were observed at some overpasses. Fox droppings were observed at several overpasses and coyotes were known to occur close to the overpasses.

Discussion

No control over the study area was possible during our investigation, and we could not dig out the burrows to locate their exact position under the pavement. Alterations at three overpasses in Ontario in May 1972 and burning of grass in the spring in Québec may have reduced the woodchuck populations. But the spring burn probably improved considerably the summer food supply on the embankments.

Moss (1940) reported that nearly 100% of burrows studied were in sandy loam. In our study, more burrows were located near the bottom of the slopes, in thinner top-soil, indicating a preference for digging substrate. But the substrate was not the only factor responsible for the range (0–73) of burrows observed at each overpass. Overpasses with no holes, or low numbers for all four censuses, were the ones situated near habitation, usually with large dogs present. One overpass without holes was surrounded by marsh area, but the slope vegetation was identical to that of other overpasses. The presence or absence of water near the embankments was not considered important, since woodchucks are not known to drink (Schoonmaker 1966).

Woodchuck dens have been reported to be 5 feet deep and as long as 40 feet (Burt and Grossenheider 1964; Caras 1967), which suggested that woodchuck excavations in the embankments may have extended under the pavement. The deepest horizontal burrow into the slope was 9 feet, 5 of which were under the pavement, indicating that embankment substrate was excellent for digging and that woodchucks can dig in the heavily compacted sections of the overpasses.

In farming areas, woodchucks favor ravines, creek banks, and fence rows (Caras 1967). Open hillsides could be favored for family dens because of adequate soil drainage and unobscured sunshine throughout the day (Schoonmaker 1966). Merriam (1971) reported that on slopes, most burrows were located on well drained sites. The areas adjacent to the overpasses examined were predominantly flat farmland. The well-drained slopes, the abundant food supply, good denning substrate, and suitable sunning sites of highway overpasses established them as very good woodchuck habitat. The embankments are free of farming activities, closed to hunting, and provided excellent observation posts over the farmland, from which to detect the approach of terrestrial predators.

Woodchucks seemingly are not disturbed by highway traffic (Manville 1966), and we noted that woodchucks moved from one bank to another by running over the pavement. This practice was probably the most important decimating factor of the population studied. The high population of *Microtus* was probably responsible for the predator activity on the embankments. The presence of foxes, cats, and dogs at several overpasses, along with the occasional presence of hawks and coyotes, constituted a threat to woodchucks. Woodchucks, especially young ones, are vulnerable to most of the predators detected in the area. Despite serious menace from predators and traffic, the density of woodchucks on overpasses for the 3 years studied was much higher (mean: 44.64 per 100 acres) than the 12 per 100 acres reported by De Vos and Merrill (1957), 18 per 100 acres (Grizzell 1955), and 10 per 100 acres (Allen and Shapton 1942), for open flatlands.

Conclusions

The high population of woodchucks observed on overpass embankments, despite the proximity of lethal road beds and high predator activity, indicated that embankments were better habitat than the adjacent areas. The well-drained slopes, excellent digging substrate, sunning sites, and the food provided by their vegetation, have made overpass embankments preferential woodchuck habitat. While some animal species are suffering a reduction of habitat due to man's activities, the construction of additional overpasses in the area provides an increase in woodchuck habitat. From either a structural or safety point of view, the activity of *Marmota monax* is of little nuisance value to the Department of Highways, but intensive burrowing on the embankments does hamper grass-mowing operations.

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Numbers and Habitat Affinities of Small Mammals in Northwestern Maine

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Abstract. Small mammals were snap-trapped in four habitats in northwestern Maine during the summer of 1969 and in five habitats in 1970. Nine species and 1,587 individuals were captured in 11,520 trap nights (TN). The redback vole (*Clethrionomys gapperi*), masked shrew (*Sorex cinereus*), and deer mouse (*Peromyscus maniculatus*) were most abundant. The shorttail shrew (*Blarina brevicauda*), the woodland jumping mouse (*Napaeozapus insignis*), and the meadow vole (*Microtus pennsylvanicus*) were captured in moderate numbers. Water, smoky, and pygmy shrews (*Sorex palustris, Sorex fumeus,* and *Microsorex hoyi*), not common in Maine, were also caught. *Clethrionomys gapperi* had no definite habitat preference, *P. maniculatus* and *B. brevicauda* preferred hardwood and mixedwood communities, and *S. cinereus* had a greater affinity for open areas. *Sorex fumeus* preferred softwood and mixedwood stands, *M. pennsylvanicus* grassy open areas, and *S. palustris* areas within 15 m of water. The habitat affinities of *N. insignis* and *M. hoyi* were uncertain.

There are few studies of small mammals in Maine and most have been limited to species surveys on localized areas (Dutcher 1903; Pope 1922; Norton 1930; Manville 1942, 1964; Gibbs 1961; Moulton 1963). Copeland and Pope (1917) and Jackson (1928) listed species of small mammals from many localities, and Palmer (1937) summarized the known distribution of mammals in Maine. The ecology of small mammals in Maine is not well known.

Description of Study Area

The study area lies on the eastern edge of the White Mountain Plateau within Somerset County, at about 45°15′ latitude and 70°10′ longitude. Elevation ranges from 335 to 400 m above mean sea level. The area is interspersed with abrupt rocky hills, ponds and streams, and the run-off drains into the Dead River. The mean annual precipitation is 102 cm and snow covers the ground an average of 124 days each year. The predominant soils are shallow, stony loams which are strongly acid and have developed from glacial till (Lull 1968).

I classified the plant cover as softwood, hardwood, mixedwood, open and streamside habitats. Dominants of the softwood community are red and black spruce (*Picea rubens* and *P. mariana*), balsam fir (*Abies balsamea*) and northern white cedar (*Thuja occidentalis*), but eastern hemlock (*Tsuga canadensis*), and white and red pine (*Pinus strobus* and *P. resinosa*) are scattered throughout. Spruce and fir are climax softwoods for this area.

Beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and red maple (*Acer rubrum*) are the dominants of the hardwood habitat, but locally, striped maple (*Acer pensylvanicum*) and yellow and paper birch (*Betula lutea* and *B. papyrifera*) are important components. This is a subclimax community and its persistence is probably related to past cutting practices.

The mixedwood community is characterized by mature hemlock, pine, beech, and maple above an understory of young spruce and fir. This community is at an intermediate stage of succession toward a spruce-fir climax.

The open habitat is mainly the result of clearcutting softwoods. Clearcuts are quickly invaded by such seral species as red raspberry (*Rubus idaeus*), pin cherry (*Prunus pensylvanica*), and quaking aspen (*Populus tremuloides*). Later in the sere, seedlings of the dominant softwoods appear in great numbers.

The streams are bordered by stands of mature spruce, fir, and cedar but large maple, birch, and ash (*Fraxinus* spp.) trees are also common in the streamside habitat. Openings resulting from fallen trees or stream-course changes support cover similar to that of the open habitat.

[1]The Maine Department of Inland Fisheries and Game, Bureau of Sport Fisheries and Wildlife, University of Maine, and the Wildlife Management Institute, cooperating.

Methods

Vegetation and Shelters

Species composition and stocking of tree stands, abundance of shrubs and young trees, and density of plant ground-cover were determined on .01-acre (.00405 ha) circular plots centered over odd-numbered trap stations. Canopy density was determined with a spherical densiometer Model-A (P. A. Lemon, Forest Densiometers, Arlington, Virginia, U.S.A.) and tree stand height with a Spiegel Relaskop (Feinmechanische-Optische Betriebsgesellshaft, Salzberg, Austria).

Species of shrubs and young trees on the plots were classed as abundant, moderate, or sparse and numerically rated as three, two, or one, respectively; the numerical values for all plots in each habitat were then summed. Shrub and tree heights were estimated in comparison to my height. Herbs (all species combined) were classed and rated as above. Mosses were classed as continuous, patchy, sparse, or absent (rating of three, two, one, and zero, respectively); the plot numerical values were then summed for each habitat.

Numbers of the following were counted in each plot: (1) stumps, (2) exposed roots of tipped-over trees, (3) logs 15 cm or more in diameter, (4) slash piles, and (5) holes in the ground, only some of which were obvious burrows.

Trapping

Three trap blocks were established within each habitat along a main logging road. Each trap block consisted of 40 Victor snap-traps in five rows with eight traps per row, with rows and traps spaced 35 feet (10.7 m) apart, and blocks placed at least 30 m from the edge of the community being trapped. Every fourth trap was a rattrap and the others were mousetraps; they were set at the most likely spot for animal capture within 2 m of trap stations. A mixture of rolled oats and peanut butter was used as bait. Trapping was done in July, August, and September (also in June 1970) for three consecutive days each month. Traps were checked daily.

Results and Discussion

Vegetation and Shelters

The average overstory closure for each cover type was softwood 90.3%, hardwood 89.4%, mixedwood 91.1%, open 13.2%, and streamside 86.7%. Thus, except in the openings, there was an extensive tree canopy in all habitats. Mean tree height, averaging all species, was nearly the same (6.7 m) for all habitats except for hardwoods, which averaged 8.2 m high.

The shrub stratum is usually absent in softwood and mixedwood habitats but scattered seedlings of the dominant hardwoods and shrubs such as hobblebush (*Viburnum alnifolium*) and hazelnut (*Corylus cornuta*) are common in the hardwood stands. In open habitats and in openings along streams the dense ground cover includes many shrub species and young coniferous and deciduous trees. The abundance index by cover type was softwood 69, hardwood 201, mixedwood 136, open 253, and streamside 167.

Data on herbs, mosses, and shelters are summarized in Table 1. Herbs were most numerous in the more open habitats. Moss cover was most extensive along streams; in softwood and mixedwood stands it profusely covered many rocks and decaying logs, as well as the duff and leaf mold.

Trapping

Nine species of small mammals were captured in 11,520 TN. *Clethrionomys gapperi, S. cinereus,* and *P. maniculatus* constituted 87% of the captures

TABLE 1 — Ground cover and shelters present on the study area by habitat. Plots were circular and had an area of .01-acre (.00405 ha).

	Ground cover		Average number of shelters present/acre (.405 ha)					
Habitat	Herb index	Moss index	Stumps	Roots	Logs	Slash piles	Ground holes	Total
Softwood	24	65	160	13	170	13	830	1186
Hardwood	31	50	90	8	130	8	370	606
Mixedwood	30	52	110	13	150	7	530	810
Open	40	39	390	20	90	70	>800	>1570
Streamside	51	57	120	10	130	20	>800	>1280

in 1969 and 78% in 1970 (Tables 2 and 3). *Sorex palustris, S. fumeus, M. hoyi,* and *M. pennsylvanicus* appeared to be scarce, and *N. insignis* and *B. brevicauda* were not plentiful.

For this study, I assumed that the trapped population, except where otherwise stated, was representative of the actual population. Five species seemed to maintain or increase their numbers in 1970 but the total catch of small mammals in 1970 was lower than in 1969. Most of the reduction in the catch was due to the decrease of *C. gapperi* and *S. cinereus*. Many factors affect the size and composition (species, sex, and age) of small mammal populations and the cause of the population reduction is unknown.

The most numerous small mammal, *C. gapperi,* was abundant in all habitats (Table 3). The total catch in 1970 was only 58% of that in 1969, and there was an additional trapping period in the latter year (Table 2). These voles were most numerous in August of 1969 and in July of 1970 (Table 2). Morris (1955) also found *C. gapperi* to be the most numerous small mammal in New Brunswick. *Clethrionomys gapperi* were nearly as abundant in dry as in wet localities in northwestern Maine, but in Michigan, Getz (1968) found these voles to be limited to areas of plentiful moisture. Gunderson (1959) concluded that the distribution of *C. gapperi* in Minnesota was most closely correlated with the presence of stumps, rotting logs, and exposed root systems. Shelters of this type were numerous in all habitats of my study area.

Grant (1971) concluded that *M. pennsylvanicus* prefers grassland to woodland habitat in Quebec. Clough (1964) found that although *M. pennsylvanicus* and *C. gapperi* were able to live in similar habitats they seldom coexisted in them. In my study, most *M. pennsylvanicus* were captured in open areas, and in that habitat most were trapped from one grassy spot with numerous slash piles. A .4-ha stand of dense grass at the study headquarters yielded 18 *M. pennsylvanicus* and no *C. gapperi*;

TABLE 2 — Monthly captures of small mammals in Pierce Ponds Township, Maine, 1969–1970

Species	Numbers of small mammals captured					
	June	July	Aug.	Sept.	Total	Per 100 TN[1]
1969						
Clethrionomys gapperi	No trapping in 1969	148	177	108	433	10.02
Peromyscus maniculatus		29	43	33	105	2.43
Napaeozapus insignis		22	20	3	45	1.04
Microtus pennsylvanicus		1	0	0	1	.02
Sorex cinereus		61	78	97	236	5.46
Sorex fumeus		19	12	9	40	.92
Sorex palustris		0	2	0	2	.04
Blarina brevicauda		1	5	13	19	.44
Microsorex hoyi		3	3	4	10	.23
Sub total		284	340	267	891	20.60
1970						
Clethrionomys gapperi	38	84	53	75	250	3.47
Peromyscus maniculatus	18	34	44	43	139	1.93
Napaeozapus insignis	11	8	2	1	22	.31
Microtus pennsylvanicus	13	6	2	6	27	.38
Sorex cinereus	16	41	39	58	154	2.14
Sorex fumeus	0	0	4	3	7	.10
Sorex palustris	0	0	3	0	3	.04
Blarina brevicauda	4	23	33	27	87	1.21
Microsorex hoyi	2	2	1	2	7	.10
Sub total	102	198	181	215	696	9.68
Total animals captured	102	482	521	482	1,587	

[1]Trap nights.

the latter were abundant, however, in the surrounding woods.

Peromyscus maniculatus were captured in all habitats on the study area (Table 3), but they were not as evenly distributed between habitats as were *C. gapperi*. I found *P. maniculatus* to be about three times as prevalent in hardwood, mixedwood, and streamside communities as they were in softwood stands and openings. Yet, in Michigan this species preferred swamps or coniferous areas (Ozoga and Verme 1968). Ozoga and Verme (1968) found *P. maniculatus* to be generally more abundant where *C. gapperi* were less numerous, but this was not evident in my study.

Twice as many *N. insignis* were captured in 1969 as in 1970; the capture rate was greatest in the first trapping period and lowest in the last (Table 2). The streamside habitat, however, was not trapped in 1969. In 1970, I trapped along streams, and it was there that most of these mice were caught. Lovejoy (1973) in New Hampshire found more *N. insignis* near water or in the more moist localities than elsewhere, but Brower and Cade (1966) found no special association with habitats close to water in northern New York. Brower and Cade (1966) and Lovejoy (1973) felt that ground cover was important for good *N. insignis* habitat; yet, the comparatively excellent ground cover in the softwood type (Table 1) of my study area harbored few of them. Additional trapping, however, is probably needed to clarify *N. insignis* habitat preferences in Maine.

Sorex cinereus were abundant in all types and in both years but I caught only two-thirds as many of them in 1970 as in the previous year. They seemed to prefer open habitat and were least numerous in hardwood (Table 3). The catch of these shrews tended to increase as the summer progressed, with the largest monthly catch in September of each year (Table 2). Jameson (1949) suggested that *S. cinereus* are more abundant and more widely distri-

TABLE 3 — Captures of small mammals in different habitats in Pierce Ponds Township, Maine, 1969–1970

Species	Numbers of small mammals captured				
	Softwood	Hardwood	Mixedwood	Open	Streamside
1969					
Clethrionomys gapperi	92	83	151	107	No trapping in 1969
Peromyscus maniculatus	10	35	44	16	
Napaeozapus insignis	3	21	14	7	
Microtus pennsylvanicus	1	0	0	0	
Sorex cinereus	44	50	64	78	
Sorex fumeus	13	5	14	8	
Sorex palustris	0	0	0	2	
Blarina brevicauda	1	3	7	8	
Microsorex hoyi	3	1	3	3	
Sub total	167	198	297	229	
Catch/100 TN[1]	3.87	4.58	6.88	5.30	
1970					
Clethrionomys gapperi	54	42	48	54	52
Peromyscus maniculatus	12	41	33	10	43
Napaeozapus insignis	2	5	0	2	13
Microtus pennsylvanicus	4	0	0	20	3
Sorex cinereus	37	19	22	37	39
Sorex fumeus	2	0	1	1	3
Sorex palustris	0	0	0	1	2
Blarina brevicauda	16	22	23	14	12
Microsorex hoyi	0	2	2	2	1
Sub total	127	131	129	141	168
Catch/100 TN[1]	1.76	1.82	1.79	1.97	2.33
Total animals captured	294	329	426	370	168

[1]Trap nights.

buted than is evident from snap-trapping. MacLeod and Lethiecq (1963) caught many more of these shrews in pit-traps than in snap-traps. Jameson (1949) also noted that *S. cinereus* were frequently caught by their tails (near misses). I agree with these authors that populations of this shrew are likely under-represented when snap-trapped.

Three species of shrews are uncommon in Maine: *S. palustris* and *M. hoyi* are reported from several localities but in low numbers, and there are few records of *S. fumeus* (Palmer 1937). Gibbs (1961) captured three *S. palustris* but failed to catch *S. fumeus* or *M. hoyi* at Pierce Pond, 10 km east of my study area, in 1960. *Sorex fumeus* were not plentiful on my study area and most were taken in July and August 1969, in softwood and mixedwood habitats. *Sorex fumeus* are somewhat larger than *S. cinereus* and they were likely trapped in proportion to their population. I captured two *S. palustris* in northwestern Maine in August 1969 and three in August 1970, all within 15 m of streams. These catches suggest a sparse but wide distribution for *S. palustris,* as concluded by Palmer (1937).

No season or habitat trends were apparent for *M. hoyi,* owing to the small numbers trapped. According to Spencer and Pettus (1966) most of these shrews inhabit sites intermediate in character between bogs and spruce-fir forests. Habitat similar to this was not trapped extensively in my study but I believe there were many more *M. hoyi* than my trapping results suggest, as these shrews were too small to be caught consistently by snap-traps.

Blarina brevicauda occurred in all plant communities (Table 3) and there were about four times as many of them in 1970 as in 1969. Numbers of these shrews generally increased as the season progressed (Table 2). Jameson (1949) noted that *B. brevicauda* occurred in many habitats in central New York. These shrews tended to be less abundant in softwoods and more numerous in hardwoods and mixedwoods in Maine; their tunnels were locally numerous in the latter two habitats but they were never observed in softwood. In New Brunswick and the Gaspé Peninsula of Quebec, Morris (1955) indicated that *B. brevicauda* were generally rare in softwood stands but were more common under mature hardwoods where a thick leaf mold facilitates tunnelling. Over 70% of *B. brevicauda* captured by Ozoga and Verme (1968) in northern Michigan were taken in mixedwood.

Some small mammals were very unevenly distributed within what appeared to be a rather uniform habitat. Nearly the entire catch of *N. insignis* was obtained from the trap block of one hardwood stand. The other hardwood stands sampled were similar in appearance and should have provided a favorable habitat but contained few of these animals. Also, trap blocks near Basin Pond yielded most of the *S. fumeus* whereas similar areas elsewhere produced few of them. These anomalies in distribution and abundance are presumably associated with unknown habitat differences, populational characteristics, or disturbance.

The great degree of habitat interspersion in northwestern Maine creates a complicated mosaic of communities, and tends to jumble distinct habitat occupancy and preference. The association of animal species is related to community development and as the community matures the small mammal fauna changes.

Shelters were diverse and numerous in the study area and a combination of dense ground cover, fallen trees, decaying logs, slash, heaved-out roots and stumps is conducive to high small-mammal densities (Morris 1955; Ozoga and Verme 1968). There were many more shelters in the softwood, open and streamside habitats than in hardwood or mixedwood (Table 1), and yet all these habitats exhibited similar mammal densities. This implies that all habitats had ample cover for many small mammals and that population size was limited by something else, biotic or physical.

The capture rates (9.68/100 TN in 1970 and 20.6/100 TN in 1969) were indicative of high small-mammal densities in northwestern Maine. Captures in each habitat were comparable since the same techniques, materials, and personnel were used throughout the study. Differences in the populations of 1969 and 1970 reflect annual and perhaps cyclic fluctuations common to many small mammals.

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Birds of the Truelove Lowland and Adjacent Areas of Northeastern Devon Island, N.W.T.

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Abstract. Observations are presented on 38 species of birds recorded on northeastern Devon Island during the summers of 1966–1969. Of 22 breeding species, eight had not previously been reported on this part of Devon Island. Breeding records for the American Golden Plover, Pectoral Sandpiper, White-rumped Sandpiper, and Buff-breasted Sandpiper represent northerly extensions of the known ranges. The breeding season at this locality is relatively late, corresponding with a late melt. Presence of Snowy Owls and breeding of Long-tailed Jaegers were associated with high lemming populations in 1968 and 1969.

Devon Island is one of the largest islands in the Canadian arctic archipelago, yet its avifauna remains relatively unknown. In this paper we report summer bird observations from a small section of the north coast of Devon Island.

Information in the species accounts was extracted from field records mainly by Holroyd. The final version of the manuscript, including the introductory sections, was written by Hussell in consultation with Holroyd.

Localities Visited

During the summers of 1966–1969 the senior author was engaged in research on clutch size and other aspects of the breeding biology of the Lapland Longspur and the Snow Bunting (Hussell 1972) in the vicinity of the Arctic Institute of North America's research station (Base Camp) located at 75°41′ N, 84°35′ W, on the Truelove Lowland about 14 miles southwest of Cape Sparbo (Figure 1). The Truelove Lowland is one of several similar lowland areas situated between the sea and the escarpment of the interior plateau along this part of the north coast of Devon Island. The lowland is dominated by lakes, ponds, and poorly drained grassy meadows crossed by a series of raised beaches. Outcrops of granite and calcareous rock are prominent in some places. The vegetation is relatively rich (Polunin 1948; Barrett and Teeri 1973) and supports a population of muskoxen (*Ovibos moschatus*). The escarpment bordering the lowland rises steeply to about the 1000-ft contour, beyond which the elevation of the land increases more gradually inland towards the icecap. The plateau is extremely barren and in many places is almost devoid of vegetation.

More detailed accounts of the topography and vegetation of the lowland may be found in Bliss and Teeri (1971) and Barrett and Teeri (1973). A wide variety of studies, sponsored by the Arctic Institute, have been carried out in this area (for examples, see Barr et al. 1968; Elcock et al. 1972) and the Truelove Lowland has recently been the site of the Canadian IBP (International Biological Program) High Arctic Ecosystem Study (Bliss and Teeri 1971; Bliss 1972).

Hussell stayed on Devon Island from 11 June to 14 August 1966; 9 June to 11 August 1967; 7 June to 26 August 1968; and 8 June to 13 August 1969. Field assistance was provided by R. W. Stamp in 1969 (from 29 June), G. L. Holroyd in 1967 (until 29 August), G. W. Page in 1968, and D. C. Smith in 1969. Other researchers and visitors to the Arctic Institute camp also contributed observations to this paper, including records of birds seen before our arrival on Devon Island in 1967 and 1969.

Most of our observations are from the Truelove Lowland (Figure 1), where we spent nearly all of our time. Trips were made to the plateau and the icecap southeast of the Base Camp by Hussell and Stamp from 2 to 6 August 1966 and by Hussell and Page from 9 to 11 August 1968. The Sparbo-Hardy Lowland was visited by Hussell and Stamp from 8 to 11 August 1966, and Holroyd stayed on the Skogn Lowland from 18 to 20 August 1967. Brief

visits were made to the plateau and Skogn Lowland at other times.

Weather

A summary of climatic data for the four years is given in Table 1. Mean temperatures are the average of daily maximum and minimum temperatures recorded in a screen approximately 5 feet above ground level at the Base Camp. Temperatures were recorded from a maximum-minimum thermometer in 1966 and by a recording hygrothermograph in the other three years. Mean temperature for June 16–30, 1966 is an estimate based on data for June 22–30 only.

The figures shown (in Table 1) for inches of precipitation at the Base Camp are followed by the days of measurable rain (in parentheses). In 1967 precipitation measurements started on June 21. Days of measurable rain for June 16–30, 1967 and for all of 1966 are estimates based partly or entirely on general weather notes recorded daily. Snow cover is an estimate of the percentage of ground (excluding lakes and ponds) covered with snow in an area of about a square mile immediately south of the Base Camp. Dates shown are the earliest dates on which the estimated percentages of snow cover were attained.

Northeastern Devon Island has a rather late melt compared to some other areas in the High Arctic (see Parmelee and MacDonald 1960). Loss of snow cover normally started in earnest in the third week of June and was essentially complete by the end of the month, but in 1968 the melt was slower and there was still 50% snow cover in the vicinity of the Base Camp on 3 July. In 1969 the melt started late but was completed very rapidly.

Correlated with the timing of the melt, temperatures in the second half of June and first half of July averaged higher in 1966 and 1967 than in 1968 and 1969. Temperatures were below average throughout the 1968 season.

Precipitation was typically low in June and increased following the melt in July and August. The cooler temperatures in 1968, however, were associated with low precipitation in July and August. Fog, mist, and relatively light winds are frequent on the Truelove Lowland, but there are also periods of strong, warm, katabatic south winds during the spring and summer.

Breakup of the sea ice in Jones Sound normally occurs about the end of July, but in 1968 it was delayed until 9 August.

TABLE 1 — Climatic data, Truelove Lowland

	Year			
	1966	1967	1968	1969
Mean temperature (°F)				
June 16–30	(36.4)	36.1	32.3	32.6
July 1–15	40.5	42.2	35.4	36.5
July 16–31	40.0	43.9	36.2	40.6
August 1–15	—[1]	37.9	36.2	39.7
Precipitation (inches and days)				
June 16–30	— (3)	0.12+ (4)	0.02 (1)	0.05 (2)
July 1–15	— (4)	0.57 (6)	0.08 (2)	1.06 (7)
July 16–31	— (6)	1.22 (9)	0.05 (2)	0.86 (11)
August 1–15	— (—)	— (—)	0.11 (3)	0.95 (13)
Snow cover (%)				
80	18 June	15 June	22 June	20 June
50	22 June	21 June	3 July	25 June
20	26 June	26 June	8 July	27 June
Sea ice breakup	28 July	ca. 28 July	9 August	4 August

[1]A dash (—) indicates that no data were available.

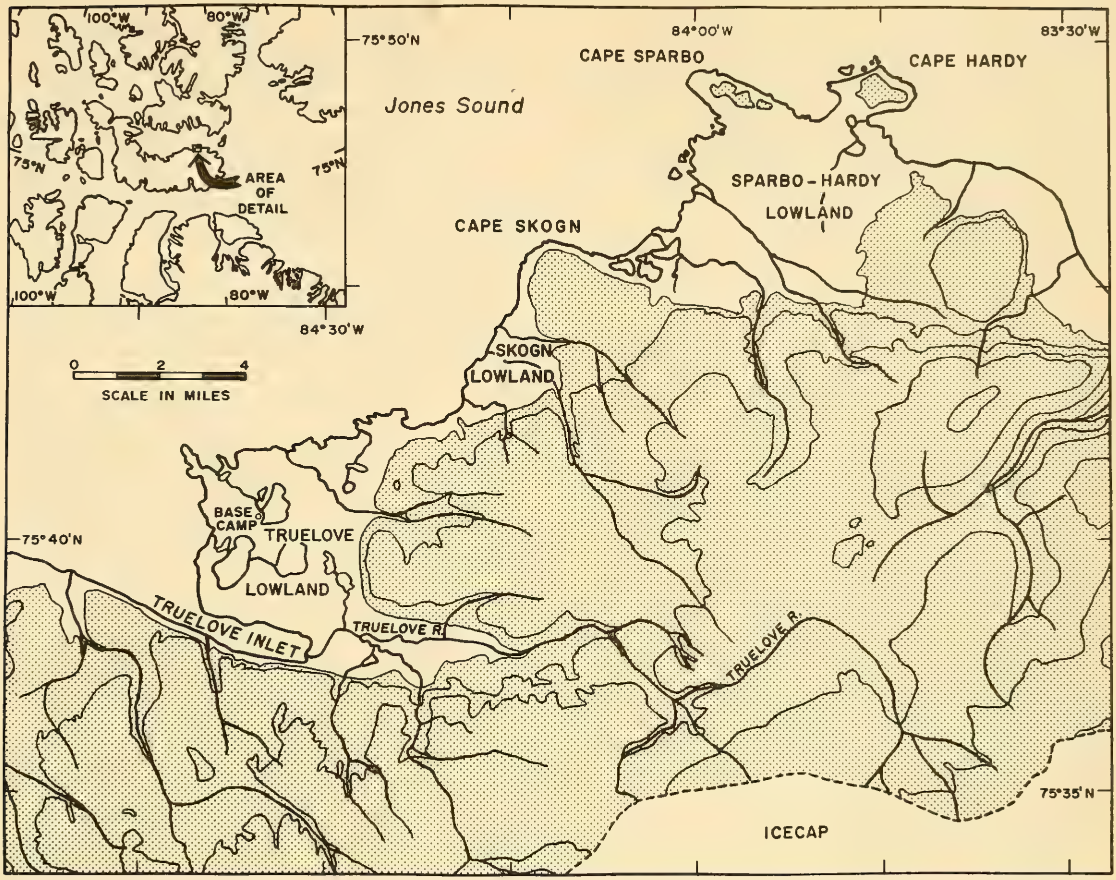

FIGURE 1. Map of the north coast of Devon Island between Truelove Inlet and Cape Hardy. The contour interval is 500 feet. Land above the 500-foot contour is stippled.

Lemmings and Their Predators

The lemming population was very low in 1966 and increased each year until 1969 (Table 2). Each figure in Table 2 is the total number of lemmings captured in two standard traplines (A and B) consisting of 60 unbaited mousetraps set at burrow entrances along a length of raised beach and nearby areas. The traps were distributed as uniformly as possible along the length of the beach and, when possible, were set preferentially at burrows showing signs of recent occupancy, but they were never set closer than 2 feet apart. Traps were set about midday and checked at 24-hour intervals for 3 days. Traps sprung after 1 and 2 days were reset. Traplines A and B were located about 1/2 mile northwest and southeast of the Base Camp, respectively. Dates on which traplines were first set are as follows.

1967. Early: A, June 26; B, July 3. Late: A, July 31; B, August 15.
1968. Early: A, July 5; B, July 1. Late: A, August 13; B, August 13.
1969. Early: A, June 26; B, June 27. Late: A, August 2; B, August 4.

No traps were set in 1966.

TABLE 2 — Population indices for lemmings, *Dicrostonyx groenlandicus*

Year	Trapline captures: Early	Trapline captures: Late	Number observed by Hussell June 11–30
1966	—	—	0
1967	4	1	2
1968	18	5	17
1969	39	12	7

Presence of Snowy Owls and breeding of Long-tailed Jaegers in 1968 and 1969 were apparently related to the size of the lemming populations. Weasels (*Mustela erminea*) were seen only in 1969. Arctic foxes (*Alopex lagopus*) were present each year and were important bird predators, but the only litter was found in 1969 when lemmings were abundant.

Timing of the Breeding Season

Associated with the late melt, the timing of breeding in many species is later on the Truelove Lowland than at most other places in the North American Arctic, including some places farther north. Evidently Bylot Island (73° N), just south of Devon Island, has a similarly late breeding season (Van Tyne and Drury 1959; Drury 1961a, b, c), but breeding of most species at Eureka and Hazen Lake, Ellesmere Island (80° and 82° N, respectively) usually starts earlier (Parmelee and MacDonald 1960; Savile and Oliver 1964; Maher 1970). Ellesmere Island dates are more comparable to those at Cambridge Bay, Victoria Island (69° N) and nearby Jenny Lind Island (Parmelee et al. 1967), and even to localities much farther south, such as Frobisher Bay, Baffin Island (e.g., Sutton and Parmelee 1954, 1955), and Churchill, Manitoba (Jehl and Smith 1970; Hussell 1972).

Variability in the timing of breeding in the four summers on Devon Island was less marked than might have been expected from differences in the weather. The 1966 and 1967 seasons may be characterized as early and warm, while those of 1968 and 1969 were relatively late and cool. The summer of 1968 was exceptional, however, in having both a prolonged melt and unusually low precipitation.

Three exceptional nesting attempts, those of the American Golden Plover, the Pectoral Sandpiper, and the Buff-breasted Sandpiper, represent northerly extensions of the breeding range and all occurred in 1967. It is significant, perhaps, that the 1967 season was the earliest and warmest of the four summers.

The best comparative data for the four years are for the Lapland Longspur and Snow Bunting (Table 3). For the longspur, laying dates were later in 1968 and 1969 than in the previous two years, but changes in population levels were even more marked. In 1968 and 1969 the population in the vicinity of the Base Camp was about 20% of that in 1966 and 1967, and many of the longspurs that bred did so in other areas (for example, on the south-facing slopes of Truelove Inlet) which were free of snow earlier. Similar effects on distribution and nesting dates were noted or suspected for the Snow Bunting and other species. The median dates for the four years (Table 3) are not strictly comparable, partly because of small sample sizes in some years and partly because our coverage of different parts of the lowland varied between years. For example, in 1968 and 1969 we searched for Snow Bunting nests more thoroughly in areas which were free of snow relatively early and we probably found a greater proportion of the earliest breeding Snow Buntings in those two years than in the previous two. Recognizing the limitations of the data, we think, however, that these breeding dates support our impression that changes in the local distribution of birds

TABLE 3 — Dates of laying first eggs in Lapland Longspur and Snow Bunting nests on Devon Island[1]

	Year			
	1966	1967	1968	1969
Lapland Longspur				
Median	26 June	26 June	27 June	30 June
Range	20 June–6 July	18 June–12 July	22 June–9 July	27 June–11 July
Sample size	19	24	14	6
Snow Bunting				
Median	23 June	28 June	26 June	27 June
Range	20–26 June	22 June–7 July	16 June–7 July	17 June–4 July
Sample size	8	13	24	31

[1]Dates of laying of first eggs were determined from direct observations, or estimated from dates of laying of subsequent eggs, hatching dates, or weight and development of the young. Nests for which data were inadequate to make accurate estimates were excluded.

resulted in a less marked change in the timing of breeding than might have been anticipated from differences in the timing of the melt.

Breeding Range Revisions

Thirty-eight species were recorded on Devon Island in the four summers and 22 of these have been proved to breed. The breeding records for American Golden Plover, Pectoral Sandpiper, White-rumped Sandpiper, and Buff-breasted Sandpiper represent northerly extensions of the breeding ranges shown by Godfrey (1966). Of these, however, apparently only the White-rumped Sandpiper is a regular breeder in our area.

Our records for the Common Eider, Ruddy Turnstone, Sanderling, and Red Phalarope show that the breeding ranges of these species in Godfrey (1966) should be extended to cover northeastern Devon Island, although all except the Common Eider are more or less irregular in occurrence. On the other hand we found no evidence of breeding for the Brant, Ringed Plover, Thayer's Gull, Black Guillemot, or Horned Lark. We did not prove breeding for four other species whose ranges in Godfrey (1966) include northeastern Devon Island, but we suspected breeding in the cases of the Purple Sandpiper and Raven, and it is reasonable to suppose that Snowy Owls and Gyrfalcons might breed in the area occasionally.

Specimens, Nest Records, and Definitions

One hundred and two specimens (100 skins, 1 skeleton, and 1 egg with an embryo) were collected. Of these, 95 skins and one skeleton are now in the University of Michigan Museum of Zoology (UMMZ), four skins are in the collection of the Department of Zoology, University of Western Ontario, one skin is in the San Diego Museum of Natural History, and the egg and embryo are in the National Museum of Natural Sciences, Ottawa (NMC).

Three hundred and sixty-five occupied nests were recorded. Nest record cards for Lapland Longspurs and Snow Buntings will be deposited with the North American Nest Record Card Program at the Laboratory of Ornithology, Cornell University. Record cards for all other species are in the Prairie Nest Records Scheme at the Manitoba Museum of Man and Nature, Winnipeg.

In this paper "clutch size" refers to completed clutches, determined by repeated visits to nests or by criteria similar to those used by Hussell (1972) for determining Lapland Longspur and Snow Bunting clutch sizes, but modified appropriately for the species concerned. Incubation periods are from the laying to the hatching of the last egg laid in a clutch. Estimated laying dates are calculated from known dates of laying of other eggs, or from hatching dates, or from weight or size of the young, taking into account appropriate laying intervals, incubation periods, and growth rates.

Annotated List

RED-THROATED LOON. *Gavia stellata.* Red-throated Loons were common and conspicuous breeders on the Truelove Lowland. The first arrivals were recorded on 18, 18, 17, and 19 June in the four years. Usually the earliest birds were seen in flight over the lowland before there was enough open water for them to land, and it was not until several days later that the melt had progressed sufficiently for them to be seen commonly on the lakes and ponds.

We recorded a total of 31 nests with a maximum of 13 in 1967, but the species appeared to be equally abundant in all years and a considerably larger number of nests could probably have been found if we had made a special effort to look for them. Most of the nests were on small existing islands in shallow lakes and ponds, but some were on the shores and others were on little islands of matted vegetation which appeared to have been built by the birds. There were no nests on the three large deep lakes on the lowland and this may have been related to the late occurrence of floating ice, which would have been a danger to nest sites on these lakes. These large lakes were used for feeding, but many loons also fed on the sea, and during August they were seen flying inland carrying fish, presumably to feed their young.

Loons were late nesters. Laying occurred from 2 July (1966) until at least 13 July (1967). The latest egg was seen on 1 August 1967, but with an incubation period of 25–26 days (Parmelee et al. 1967) eggs laid on 13 July would not hatch until 7–8 August. In eight clutches believed to be complete, seven contained two eggs and one contained only one. Predation was heavy. Eggs were known to have hatched in only four of the 31 nests, while eggs disappeared from at least 11 nests, under circumstances suggesting predation. The earliest date for young was 30 July 1966 when a dead newly-hatched bird was found (UMMZ No. 212,788). Two young were seen with adults on a pond near Cape Sparbo on 9 August 1966. On 1 August 1967 one of two newly-hatched young was collected (UMMZ No. 215,885) and in mid-August two other young were seen for several days on another pond in the Truelove Lowland. In 1968 at least four broods were observed between 6 and 22 August. Two young seen on 22 August still appeared to be no more than one-third grown. Little is known about the development of the young. Witherby et al. (1940–1941) describe the fledging period as "long, probably about 8 weeks," while Palmer (1962) says the age at first flight is "unknown, probably about 2 months." Geale (1971) comments on the presence of flightless young on Cornwallis Island in early September shortly before freeze-up. At this latitude young Red-throated Loons must make their way to the open sea when they are considerably less than two months old if they are to escape being trapped in the freshwater lakes at freeze-up, but the manner in which this journey is made and the age at first flight remain to be determined.

NORTHERN FULMAR. *Fulmarus glacialis*. Several groups of up to a dozen Fulmars were seen over the ice of Jones Sound on 25 June 1966 by Milton M. R. Freeman (personal communication) while he was crossing to Ellesmere Island. We noted about 30 over the sea during half an hour of observation on 28 July 1966, the day the ice broke up in Jones Sound, and several more were seen on other days in 1966, 1967, and 1969. On 9 August 1966 about 250 were resting on the sea off Cape Sparbo.

BRANT. *Branta bernicla*. Two light-breasted Brant were seen in flight on 23 June 1966. Two "dark geese" observed on the lowland the previous evening by Akpalleapik, an Eskimo from Grise Fiord (M. M. R. Freeman, personal communication), were presumably the same individuals. A flock of about 130 birds seen over the sea in poor light by G. W. Page on 19 August 1968 were believed to be Brant.

SNOW GOOSE. *Chen caerulescens*. We saw Snow Geese within a day or two of our arrival on Devon Island each year and in 1967 W. Barr reported that they were present during the week before we arrived (i.e. before 9 June). R. Tufft, who was on Devon Island for several weeks before we were in 1969, first saw Snow Geese on 7 June that year. Thus it appears that Snow Geese are usually present on Devon Island by the end of the first week of June. Pairs and small flocks (maximum 22) were seen frequently until late June each year.

Widely scattered pairs bred on the Truelove Lowland, but there were probably no more than four or five pairs breeding in any year. In 1966 one nest was found and at least two other broods were seen. Two nests were found in 1967, none in 1968, and one in 1969. Snow Geese laid eggs earlier than most other species; laying in two nests commenced on 14 and 18 June, and in two others no later than 16 and 20 June. Laying began as early as 8 June in the relatively dense population on Bylot Island (Lemieux 1959) even though the breeding season of other species on Bylot Island is apparently as late as on Devon Island (Tuck and Lemieux 1959; Drury 1961a, b, c). Completed clutches in three nests on Devon Island were of five, three, and two eggs. An adult female banded at a nest near the Base Camp on 1 July 1967 was reported by L. Bouckhout at a nest about 4 miles northeast of the camp during the summer of 1970.

After late June larger flocks of non-breeding molting adults were seen. In 1966 and 1967 these were found only on the Sparbo-Hardy Lowland, with an estimated 400 present from 9 to 11 August 1966 and 100 reported by W. Barr on 12 August 1967. In 1968 about 100 were seen regularly from 6 July to 3 August in the vicinity of some lakes in the southeastern part of the Truelove Lowland. Forty were in the same place on 4 July 1969, but the area was not checked as regularly that year. By 6 August 1968 many of the molted geese could fly and flocks of from 15 to 95 were recorded in other parts of the lowland until 20 August 1968. A flock of 20 was seen as late as 27 August in 1967.

In 1968 a bird in typical blue-phase plumage was seen on several dates from 26 June to 14 August. (We follow Godfrey (1966) here in regarding blue- and white-plumaged birds as representing color phases of *Chen caerulescens*.) The blue individual appeared similar in size to the molting white-plumaged geese which it accompanied.

A female Snow Goose collected on 8 July 1966 (UMMZ No. 212,789) had a wing chord of 457 mm, tail of 135 mm, and exposed culmen of 61 mm. The wing measurement is in the range for female *C. c. atlantica* and well outside that for *C. c. hyperborea*, as given by Godfrey (1966). It is not known whether this was a local breeding bird. The influx of relatively large numbers of non-breeders at the end of June and the presence of a blue-phase bird indicate that many of the molting birds may not be representative of the local breeding population, but their origin is unknown.

OLDSQUAW. *Clangula hyemalis*. This was the most abundant waterfowl on the Truelove Lowland. First arrivals appeared on 16, 11, 18, and 19 June in the four years, and after the third week of June, pairs and small flocks were seen on many of the lakes and ponds on the lowland.

Oldsquaws were common breeders, but the presence of loafing adults of both sexes throughout the season and the relatively small number of nests and broods found by us indicate that there was probably a substantial non-breeding population. We recorded 14 nests. The earliest egg was found on 29 June 1966, but a nest containing three eggs on 30 June 1968 shows that laying may have started as early as 28 June in that year. The peak laying period was probably in the first week of July. Completed clutches were of 5, 5, 6, 6, and 7 eggs. At least five of the nests were apparently lost to predators and another was abandoned when it was flooded. Eggs hatched in one nest on 3 and 4 August 1967—the only one of our 14 nests in which the eggs were known to have hatched. Broods were recorded as follows: one on 28 July 1966; at least four between 3 and 28 August 1967; and at least two between 12 and 22 August 1968. Flocks of 20 to 50 birds were often seen from late July until we left the area in August (latest observation: 20 on 28 August 1967). On 8 August 1966 a flock of 250, all apparently males, was seen on the sea close to the shore of the Sparbo-Hardy Lowland.

COMMON EIDER. *Somateria mollissima*. Common Eiders arrived on Devon Island later than Oldsquaws and King Eiders. The earliest dates were 24, 23, and 24 June in 1967, 1968, and 1969, respectively. In 1966 Common Eiders were first identified on 28 June, but earlier arrivals that year may have been overlooked.

Solitary pairs nested on the shores of at least one of the large lakes on the lowland, but others bred colonially on grassy islands in one of the smaller lakes near the coast, where Arctic Terns also bred. Nine solitary nests were found in the four years, and in 1967 an additional nine nests were examined on three islands in the lake mentioned previously. In most nests laying started between 6 and 13 July, but one nest contained three eggs on 5 July 1968, so laying presumably started no later than 3 July. In two nests in 1967 it was estimated that laying did not start until about 25 July. Among 13 clutches known to be complete, there were six of 3, three of 4, and four of 5 eggs—mean 3.8 eggs.

The incubation period in one nest was about 24 days. This nest contained three eggs on 10 July 1967 and five eggs on 15 July (so presumably the last egg was laid on 12 July). All the eggs hatched in the early hours of 5 August. This is a shorter incubation period than that usually given in the literature. Gross (1938) determined the incubation period at one nest on Kent Island, New Brunswick, as 28 days. Several other authors give periods of 27 to 29 days (Witherby et al. 1940–1941; Kortright 1942; Delacour 1959; Godfrey 1966), but Lack (1968, p. 349) shows the incubation period of the Common Eider as 25 days. For 62 nests in the St. Lawrence River estuary, however, the mean incubation period was 25.8 days with a range of 23–30 days (Guignion 1968). The short incubation period on Devon Island is supported by observations on the hatching of an egg which we removed from a deserted nest in 1967 and placed successively in nests of a

King Eider and another Common Eider. This egg hatched on 1 August, about 23 days after the last egg in its clutch was laid (the nest contained three eggs on 8 July and four eggs on 10 July). As hatching is usually highly synchronous in eider clutches this is a good estimate of the incubation period, if we assume that the environment provided by the foster parents was similar to that under normal conditions. The downy young from this egg was collected (UMMZ No. 215,886).

Of the 18 nests we observed, eggs apparently hatched successfully in at least seven. Hatching dates in these nests ranged from 4 to 21 August, but most were before 10 August. Four of the nests were robbed by predators, one was deserted, and in one all of the eggs proved to be infertile. The fate of the remaining five nests was uncertain. We have no records of broods being seen on the pools in the lowland, and we assume that they soon moved to the sea.

The female at the nest at which the 24-day incubation period was determined was banded on 27 July 1967. On 17 July 1969 she was found incubating a clutch of five eggs (later found to be infertile) at a nest close to the 1967 site; the band number was read with binoculars on 4 August 1969. Another female banded at a nest on 10 July 1967 was reported shot at Kangatsiak on the west coast of Greenland (68°20′ N, 53°30′ W) on 5 April 1970.

KING EIDER. *Somateria spectabilis*. King Eiders were first seen on 16, 11, 18, and 21 June in the four years, and they became abundant in late June as soon as there was sufficient open water in the lowland pools. They were common breeders on the Truelove Lowland. Some nests were situated near the shore of a lake or pond, but many were not closely associated with water.

We have records of 19 nests for the four summers. First eggs were known or estimated to have been laid from 28 June to 12 July and it appeared that the peak laying period was during the first week of July. Among eight completed clutches, two were of three eggs, three of four eggs, and three of five eggs. Two nests with six eggs were also found, but we were not sure that the clutches were complete. King Eider nests were subject to heavy predation, probably mainly by Parasitic Jaegers and arctic foxes. Eleven of our 19 nests were apparently lost to predators, one was flooded, and one was deserted; eggs hatched successfully in three nests and the fate of the other three was not determined. Two newly-hatched downy young were collected, one on 1 August 1967 and the other on 31 July 1969 (UMMZ No. 215,887 and No. 215,943, respectively). Very few broods were noted on the lowland. A female with two ducklings was seen on 9 August 1969 and one with six young, more than half grown, from 17 to 22 August 1968. By mid-July most of the males had left the area. In late July and in August small flocks of non-breeding females, rarely numbering more than 20, were found on the lowland pools.

GYRFALCON. *Falco rusticolus*. The head and body of a white-plumaged bird were found separately on 26 June and 7 July 1969, respectively. The bird had presumably died during the previous winter and become buried in the snow. The skeleton is now in the collection of the University of Michigan Museum of Zoology (UMMZ No. 215,753). A gray bird was seen by D. C. Smith on 17 June 1969. Falcons were seen on several other occasions but the species was not determined. Birds seen on 5 July 1966 and 6 July 1969 were probably Gyrfalcons. The identity of other falcons seen on 8 July 1968 and 14 July 1969 was less certain.

PEREGRINE. *Falco peregrinus*. One was seen by D. C. Smith on 20 July 1969. It was viewed at rest and in flight; the dark facial markings were clearly seen.

ROCK PTARMIGAN. *Lagopus mutus*. None was seen in 1966. W. Barr found a ptarmigan foot on the Sparbo-Hardy Lowland on 12 August 1967. In the same year A. Gill reported seeing about 25 birds on the Skogn Lowland about 15 August, but only a wing feather could be found when Holroyd visited the area from 18 to 20 August. In 1968 a pair was present in a rock outcrop near the shore north of the Base Camp on 7 June and several subsequent days. On 17 June two males were seen there, and on 3 July a female was found sitting on a nest with a male in attendance nearby. The nest contained 11 eggs when it was examined on 5 July. On 10 July the nest was empty; the female was not seen but the male was still present. In 1969 H. Simpson reported a male on about 24 June in the same vicinity, but there were no other observations of the species that year.

RINGED PLOVER. *Charadrius hiaticula*. No specimens were collected on Devon Island, but from the known breeding range of the two forms, *C. hiaticula* and *C. semipalmatus* (Snyder 1957; Godfrey 1966), and specimens collected on Bylot Island (Van Tyne and Drury 1959), it is probable that birds observed on Devon Island are *C. hiaticula*. The taxonomic status of the various populations is controversial (Wynne-Edwards 1952; Bock 1959; Smith 1969). The nomenclature used here follows Godfrey (1966) and is not necessarily intended to imply our acceptance of the specific status of the two forms in the Canadian arctic. The only observations on Devon Island were a single bird on 24 June 1967, two (possibly a pair) on 12 June 1969, and one on 28 June 1969.

AMERICAN GOLDEN PLOVER. *Pluvialis dominica*. Golden Plovers bred in our area only in 1967. In that year the first bird was seen on 20 June and the species was observed on several days until 5 July, with a maximum of seven recorded on 4 July. One was seen performing a flight display on 25 June. A nest, containing three newly-hatched young and an egg, was found on 27 July. It consisted of a depression in vegetation in a relatively dry and barren area of limestone outcroppings about a mile west of the Base Camp. One of the two adults was trapped and banded and one of the downy young was collected (UMMZ No. 215,888). The remaining egg did not hatch. The banded adult and its mate were seen about half a mile from the nest site on 30 July, behaving as though their young were nearby. In other years Golden Plovers were seen only occasionally and there was no evidence of breeding. Single birds were observed on 19 June 1966; 24, 28 June, and 9 July 1968; and 27 June and 5 July 1969.

Godfrey (1966) shows southern Devon Island within the breeding range for the species and says of it "probably north to Melville and Devon Islands, but confirmation is needed." Our breeding record probably represents the most northerly breeding locality for the species, but it is evidently not a regular breeder on northeastern Devon Island.

BLACK-BELLIED PLOVER. *Squatarola squatarola*. This was a regular breeding bird, between five and 10 pairs probably occupying the Truelove Lowland each year. Some individuals arrived very early, the first dates being 11, 12, 11, and 14 June in the four years, but most did not appear until after 15 June. Seventeen nests were found in the four summers, seven of them

in 1968 when particular attention was paid to the breeding of this species. Dates of laying of first eggs were known or estimated to range from 19 June to 1 July. Clutch size was invariably four eggs. Hatching occurred from 20 July to 2 August. Two newly-hatched downy young were collected, on 24 July 1966 and 29 July 1967 (UMMZ Nos. 212,791 and 215,889), as well as eight banded young of known ages up to 23 days (UMMZ Nos. 215,906 through 215,912, and 215,944). The breeding biology of this species will be described in more detail elsewhere (Hussell and Page, in preparation).

RUDDY TURNSTONE. *Arenaria interpres*. Turnstones were scarce breeders in the area, but small numbers (maximum 13) of presumably transient birds were seen frequently. First arrivals were observed on 15, 17, 24, and 21 June in the four years. Breeding occurred in 1966 and 1968, but there was no evidence that birds seen in June and July in 1967 and 1969 stayed to breed. A nest containing four eggs was found on 17 July 1966. The eggs were pipped on 22 July and by the following day all had hatched. One of the young was collected (now in the San Diego Museum of Natural History). On 27 July 1966 another brood of at least three young was found. On 30 July 1968 a brood of four young, weighing 15.8, 15.8, 14.1, and 12.2 g, was found. The first of these downies was collected and proved to be a male (UMMZ No. 215,914). Full-grown young in autumn plumage were seen in August 1967 and 1968, but these may have been migrants. One such bird, a female, was collected on 4 August 1968 (UMMZ No. 215,913). Turnstones were recorded as late as 28 August 1967.

Ruddy Turnstones breeding on Ellesmere Island belong to the European race *A. i. interpres* (Godfrey 1953; Parmelee and MacDonald 1960). Their coloration is similar to that of European birds and banding recoveries show that they winter in the Old World, but they are intermediate in size between the New World race, *A. i. morinella,* and European populations. We took no adult specimens on Devon Island, but examination of black-and-white photographs and color slides of the pair trapped at the first nest found in 1966 gives us no reason to suppose that the Devon Island birds are not also *interpres*, as would be expected from the known range. The origin of the immature female collected on Devon Island is unknown; it is dark, like Ellesmere Island birds. This characteristic is said to separate *interpres* from the lighter-colored *morinella* (Godfrey 1953; Parmelee and MacDonald 1960), but Parmelee et al. (1967) found that most young *A. i. morinella* collected at Cambridge Bay, Victoria Island were also dark. The two Devon Island downies are very similar in coloration to four Canadian specimens in the Canadian National Museum of Natural Sciences and four in the Royal Ontario Museum; three of these are from Ellesmere Island, one from Victoria Island, two from Southampton Island, and two from Taverner Bay on the west coast of Baffin Island.

KNOT. *Calidris canutus*. This species was a moderately common transient and an irregular breeder in the area. Knots were seen in ones and twos and occasionally in larger groups of up to 20 birds from mid-June until the end of July each year. The latest record was a flock of six near the Base Camp on 9 August 1969.

No nests were found, but downy young were located in 1967 and 1968. On 28 July 1967 two large downy young, attended by an adult, were found on the lowland near the Base Camp. One of the young was collected (UMMZ No. 215,890); its outer primary was 34.0 mm long. On 29 July 1968 an adult was attending at least three small downy young about $1^1/_2$ miles south of the Base Camp. The young weighed 38.1, 37.8, and 33.2 g, and their outer primaries measured 12.5, 13.0, and 9.5 mm, respectively. The first of these downies was collected (UMMZ No. 215,915). On Jenny Lind Island, Parmelee et al. (1967) found a brood in which the young appeared to be of slightly different ages, and they suggested that asynchronous hatching might be responsible. An adult Knot, presumably the bird first seen on 29 July, was present in the same general area until at least 8 August 1968. On 1 August the fourth member of the brood was found; its outer primary was 15.5 mm long. Knots were seen performing display flights on 19 and 29 June 1969, but there was no other evidence of breeding in the area.

An adult male, not necessarily a local breeder, was collected on 4 July 1966 (UMMZ No. 212,792). It is deep rufous ventrally and has the dark upper parts with extensive areas of black feathers edged with buff (rather than white), which is typical of *Calidris canutus canutus,* the Old World race. Ellesmere Island Knots have been referred to this race by Godfrey (1953) and Parmelee and MacDonald (1960), and banding records confirm that they winter in the Old World (Leach 1962).

According to Godfrey (1953) and Parmelee and MacDonald (1960), downy young of *C. c. canutus* from Ellesmere Island are more buffy and less gray than young of *C. c. rufa* from Victoria Island. Hussell compared the two Devon Island downies with 10 specimens in the National Museum of Natural Sciences, Ottawa. The downy taken on Devon Island in 1967 is buffy, like four Ellesmere Island birds (two from Fosheim Peninsula and two from Alert). The second Devon Island specimen is grayer and resembles more closely four small and one medium-sized young from Taylor Island, a small island off the eastern coast of Victoria Island. Another downy from the Fosheim Peninsula, Ellesmere Island, is also very gray, and in Hussell's opinion more closely resembles the Victoria Island birds than the others from Ellesmere Island. (This was apparently one of the six Ellesmere Island young considered by Parmelee and MacDonald (1960) to be separable from Victoria Island birds.) Thus the 12 young examined are classified as follows: Ellesmere Island, four buffy, one gray; Devon Island, one buffy, one gray; Victoria Island, five gray. This suggests either that the color of the down is not as reliable a racial characteristic as supposed by Parmelee and MacDonald (1960), or that there is some interbreeding between the two forms. The presence of a sparse summering population on Prince of Wales Island (Manning and MacPherson 1961) tends to support the latter hypothesis, but examination of a larger series of specimens of both adults and young is needed to clarify the situation.

PURPLE SANDPIPER. *Erolia maritima*. One bird seen on the lowland on 6 July 1966 and others seen between 16 and 22 June 1967 were almost certainly this species. An adult male was collected on 20 June 1967 (UMMZ No. 215,891) and two more were identified on 20 June 1969. This species probably breeds in small numbers above the 1000-ft contour on the plateau. On 5 August 1966, among boulders and sparse mossy vegetation adjacent to the icecap at an elevation of about 2300 ft, 14 miles east-southeast of the Base Camp, two adults were giving alarm calls and behaving as though they had young nearby. On 11 August 1968 an adult was behaving in a similar manner near the Truelove River at about 1700 ft elevation some three miles northwest of the 1966 locality. At these elevations the plateau is extremely barren, the only others birds observed being occasional Baird's Sandpipers and Snow Buntings.

PECTORAL SANDPIPER. *Erolia melanotos*. Pectoral Sandpipers were seen only in 1967, when at least one female nested. Unfortunately no specimens were collected. The species was first identified on 19 June when the following description was recorded by Holroyd: "yellow legs, dark breast, white belly, brown back, light wing bar, white outer tail feathers, black inner tail feathers, bill $1^1/_2$–2 times head, larger than White-rumped Sandpiper." One to three birds were seen on several days until 25 June. On that day Hussell saw one performing a distinctive circling flight display ("gull-shaped wings") in which the breast was held out while the bird uttered a "bubbling" or "gurgling" note. This was apparently the hooting flight display described by Pitelka (1959). On 30 June a Pectoral Sandpiper was flushed from a nest containing four eggs (Figure 2) in a grass tussock at the edge of a small pool. The following day the eggs had gone, presumably taken by a predator, and the species was not seen again. Breeding is clearly exceptional on this part of Devon Island, and this record is well to the north of the previously known range, the most northerly portions of which are south of 75° N on Banks Island and Prince of Wales Island (Godfrey 1966).

FIGURE 2. Pectoral Sandpiper nest on the Truelove Lowland, 30 June 1967.

WHITE-RUMPED SANDPIPER. *Erolia fuscicollis*. This was the third most abundant shorebird breeding on the Truelove Lowland, only Baird's Sandpipers and Black-bellied Plovers being more numerous. White-rumped Sandpipers were, however, less common in 1969 than in the other three years. They arrived later than Baird's Sandpipers, the earliest dates being 19 June 1967 and 18 June 1968. In 1966 and 1969 they were not recorded until 30 and 26 June, respectively, but earlier arrivals may well have gone unnoticed in those years. On Bylot Island White-rumped Sandpipers arrived on 19 June in 1954 (Drury 1961b), but Tuck and Lemieux (1959) recorded the species on 10 June in 1957. The late arrival of White-rumped Sandpipers on Devon Island corresponds with the relatively late retention of snow cover in their favored nesting habitat, the wet meadows. The species was seen regularly until the time of our departure each year.

Three nests, each containing four eggs, were found on 29 June and 11 July 1967 and 9 July 1968. Three broods, each of four newly hatched young, were found on 26 and 29 July 1966 and 27 July 1967. A young bird found on 26 July 1968 weighed 22.4 g and was probably about 10 days old (Parmelee et al. 1968, p. 24). Twenty-two days being allowed for the incubation period (Parmelee et al. 1968, p. 14), this indicates a completed clutch about 24 June. Two downy young, also found on 26 July 1968, weighed 8.0 and 9.2 g and were probably about 2 days old. These young were banded and the larger was collected on 20 August 1968 when it was about 27 days old (UMMZ No. 215,916). It was a female, weighed 31.9 g, and had a wing chord of 112 mm. Its flight feathers were nearly full-grown with small sections of sheath remaining at the base of the primaries.

The breeding records for Devon Island represent a northerly extension of the range. The species breeds at Winter Harbour, Melville Island, 74°50′ N (Godfrey 1966) and on northwestern Bylot Island, 73°40′ N (Tuck and Lemieux 1959).

BAIRD'S SANDPIPER. *Erolia bairdii*. Baird's Sandpipers were the most abundant shorebirds breeding on the lowland. They bred most abundantly near Truelove Inlet, nest sites being in the drier habitats, typically in boulder-strewn areas and never in the wet meadows favored by White-rumped Sandpipers. They were among the few birds recorded on the inland plateau. On 3 August 1967, at an altitude of about 1200 ft, 5 miles east of the Base Camp, one was seen behaving as though young were nearby; and on 11 August 1968 two were seen near the Truelove River at 1700 ft, approximately 12 miles east of the camp.

Baird's Sandpipers were seen soon after our arrival on Devon Island each year, the earliest dates being 15, 12, 11, and 12 June in the four years. Eighteen nests were found in the four summers. Most laying occurred in the second half of June, but in one nest it continued until at least 5 July. One nest contained two eggs on 18 June 1968, indicating that egg-laying probably started no later than 17 June. In five other nests first eggs were estimated to have been laid on 17, 23, 27, 27 June, and 2 July. Of 12 clutches known to be complete, 11 had four eggs and one had three eggs. Incubation periods at two nests were 20 and 21 days (to the nearest day) and at another nest the clutch was incubated for at least 20 days. Drury (1961b) and Parmelee et al. (1967) reported single incubation periods of 21 days. The fate of many of the nests was not recorded. One clutch had already hatched when the nest was found, two others were known to have hatched successfully, and another probably did so. Three clutches were apparently lost to predators and one set of eggs was found crushed (we believe that a muskox lay down on the nest). The earliest newly-hatched young were found on 10 July 1968 and the latest on 30 July 1967. Downy young were collected on 30 July 1967 and 26 July 1969 (UMMZ Nos. 215,895 and 215,945, respectively). A well-feathered young, capable of flights of a few feet, was collected on 30 July 1968 (UMMZ No. 215,917). The primaries

of this bird were still partly sheathed, the outer one being about 45 mm long with 15 mm in sheath. Judged by the measurements given by Parmelee et al. (1967) for a 20-day-old bird, the age of this specimen was less than 20 days. (Measurements for our bird and the 20-day-old specimen are respectively as follows: wing chord 77.0 and 82.0 mm, tail 19.0 and 23.0 mm, exposed culmen 16.5 and 18.5 mm, tarsus 21.0 and 23.5 mm.)

The species was present on the lowland until the time of our departure each year. More than 30 were seen on 22 August 1967 and these may well have included migrants passing through the area.

BUFF-BREASTED SANDPIPER. *Tryngites subruficollis*. This species was seen only in 1967. It was first recorded on 21 June when three were seen. One was noted on 24 June, two on 3 July, one on 4 July, and one on 12 July. On 19 July two nests were found within 150 yards of each other, about a mile south of the Base Camp. Each nest contained four eggs. The incubating birds were trapped on 19 and 20 July (see Figure 3); their wing chord measurements (123 and 124 mm) indicated that both were females (Godfrey 1966). On 20 July one of the eggs in the first nest was damaged; it was collected and was found to contain a well-developed embryo (NMC No. 57,683). On the same day the eggs in the other nest were lightly pipped. On the following day both nests were empty and there was no sign of the adults in the vicinity. It was believed that the eggs were taken by a predator. On 22 July one banded adult was seen nearby, but there were no subsequent observations.

Previous breeding records for the Buff-breasted Sandpiper are all west of 95° W longitude and the most northerly locality is at about 75° N on southern Bathurst Island (Godfrey 1966). Thus the Devon Island breeding records, at 75°40′ N, 84°30′ W, are some 250 miles to the east and slightly north of the previously known breeding range. The absence of any observations of the species in three of the four summers, however, indicates that the breeding records on Devon Island were exceptional.

SANDERLING. *Crocethia alba*. Sanderlings are scarce transients and irregular breeders on the Truelove Lowland. They were seen in all years except 1966 (up to four together) on dates ranging from 11 June to 13 August, but were proved to breed only in 1967. In that year two birds were seen on 21 and 24 June, but no others were identified until 27 July when an adult was found attending three young in an area of limestone outcroppings about a mile west of the Base Camp. One of the young was collected (UMMZ No. 215,896) and the other two were banded. The wing chord of the specimen is 52 mm and its outer primary is 24 mm long with about 8 mm out of sheath, indicating that it was about 10 days old (Parmelee 1970). The adult was trapped and banded on 27 July (wing chord 122 mm, exposed culmen 24.5 mm) and was still present in the same general area on 31 July. Three Sanderlings observed on 13 August 1967 were molting into the gray autumn plumage.

RED PHALAROPE. *Phalaropus fulicarius*. Red Phalaropes were seen each year, but they were scarce and were proved to be breeding only in 1967. The earliest occurrence was on 20 June 1969 when two were seen. In 1967 the first observation was of a pair on 22 June, after which the species was seen frequently in ones and twos until the first nest, containing two eggs, was found on 4 July. This nest contained four eggs when it was next examined on 9 July, and on 22 July at least one of the eggs was lightly pipped. The eggs apparently hatched successfully but the young were not found. A second nest had four eggs when it was found on 8 July; on 18 July it contained three newly-hatched young and an egg, and on the following day four young were found about 30 feet from the nest. One of the downy young was collected (UMMZ No. 215,898). On 24 July the male attending this brood was still in the vicinity giving alarm calls. Both of the nests found in 1967 were in grassy tussocks in low-lying wet meadows. One or two Red Phalaropes were seen on several dates in July and August, and as many as six were noted on 31 July. One of two observed on 10 August was molting heavily. Our latest observation is of two in winter plumage on 28 August 1967. The presence and behavior of birds in 1968 and 1969 indicated that breeding may also have occurred in those years, but there was no definite proof.

POMARINE JAEGER. *Stercorarius pomarinus*. Single birds were seen on the Truelove Lowland on 18 June and 1 July 1968, and on 25 July 1969.

PARASITIC JAEGER. *Stercorarius parasiticus*. Parasitic Jaegers were not abundant, but there was a small breeding population on the Truelove Lowland and evidently some non-breeding birds also spent the summer in the area. First arrivals appeared on 16, 14, 12, and 14 June in the four years. The species was seen regularly after mid-June each year but there was never any indication that the maximum number present on the lowland at any one time exceeded eight. Two nests were found each year in 1967, 1968, and 1969. The locations of the breeding territories, separated by a distance of about 2 miles, changed little in the three years, and in each year one of the territories was occupied by a pair consisting of one light-phase and one dark-phase bird, and the other by two light-phase birds. No nests were found in 1966, but the number and distribution of birds in the area was similar to that in other years, so it is probable that breeding also occurred that year.

Incomplete clutches of one egg were found on 22 and 25 June 1969. These nests each had two eggs on 25 and 26 June, respectively. Two nests found on 4 July 1968, one on 11 July 1967, and one on 23 July 1967 each contained two eggs. In 1967 the eggs in the first nest hatched between 18 and 20 July and in the second between 25 and 28 July. The smaller of the two downy young from the first nest was collected on 25 July (UMMZ No. 215,899). The other young was confined in a chicken-wire enclosure so that the pellets it regurgitated could be found and examined. It was present in the enclosure until at least 28 July and was seen nearby on 8 August. An enclosure was also placed around the second nest but we were unsuccessful in obtaining any pellets from it. An egg or small young disappeared from this enclosure between 25 and 28 July, but the remaining young stayed in it until at least 5 August. This nest was observed from a blind from 0107 until 0712 (mean solar time) on 5 August. Except for two 10-minute periods at least one of the adults (one light- and one dark-phase) was always in attendance at the nest. The young, which was no more than 11 days old, was brooded for only three periods of less than 10 minutes each between 0143 and 0447, always by the light-phase adult. It was fed by both adults at about 0314, after which there was no further feeding during the observation period. The fate of nests in other years was not followed closely, but a large young with some down still adhering to its head was collected in one of the territories on 13 August 1968 (UMMZ No. 215,918).

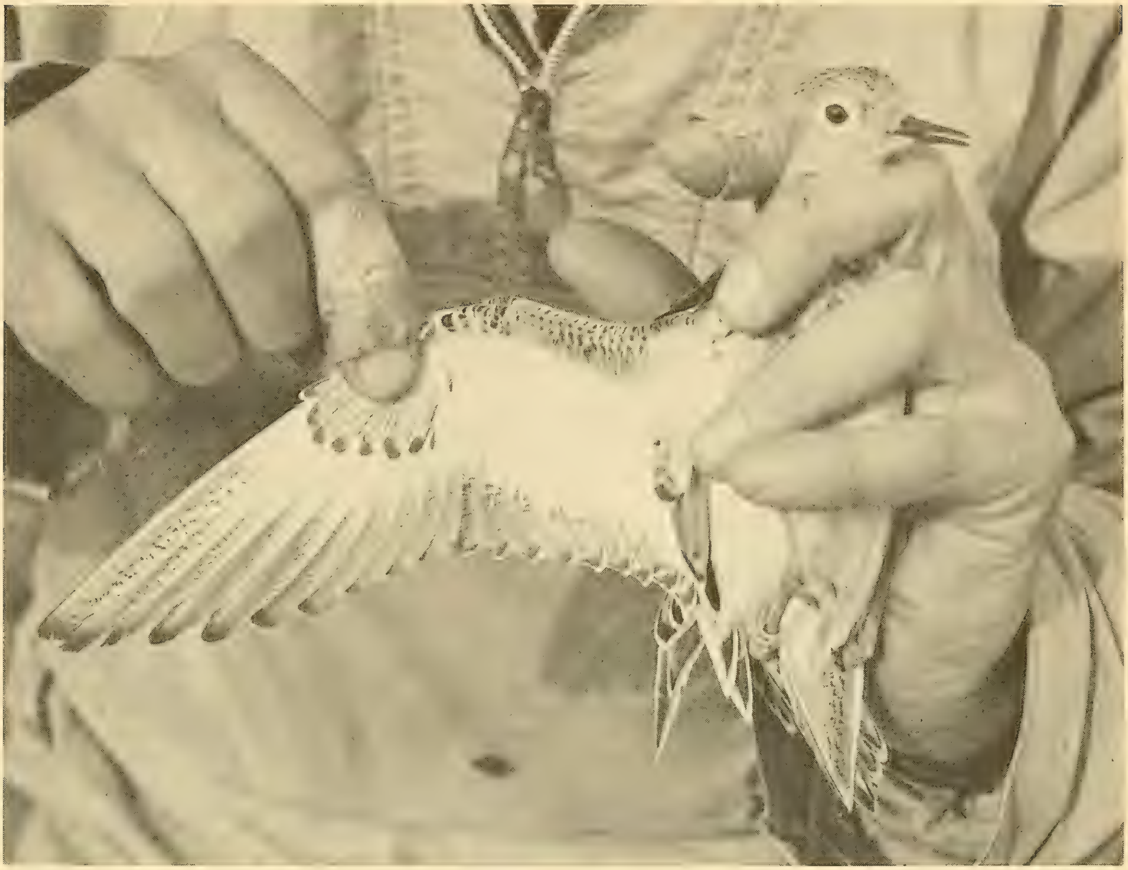

FIGURE 3. Adult female Buff-breasted Sandpiper trapped at a nest on the Truelove Lowland on 19 July 1967.

Stomach contents of the two young collected in 1967 and 1968, and contents of pellets from the confined young in 1967 are given in Table 4. Thirty-nine food items were identified, the largest proportion of the biomass consisting of small birds. This is consistent with the apparently successful breeding of Parasitic Jaegers in 1967, when lemmings were relatively scarce (Table 2). The young bird collected in 1968, however, had eaten a lemming.

LONG-TAILED JAEGER. *Stercorarius longicaudus*. This species bred on the Truelove Lowland in 1968 and 1969 when lemming populations were relatively high (Table 2). Long-tailed Jaegers were seen killing or eating lemmings on 20 and 26 June 1968 and on 19 June 1969, and it appears probable that high lemming populations are required for them to attempt breeding in this area. There was no evidence of breeding in 1966 or 1967, but large numbers of non-breeding individuals were present. The crop and stomach contents of several adults collected in 1966 and 1967 consisted almost entirely of arthropods, and no lemming remains were found (Table 5). Maher (1970) comments on the relative importance of arthropods and lemmings in the diet of Long-tailed Jaegers on Ellesmere Island.

Long-tailed Jaegers appeared soon after our arrival on Devon Island each year: they were first observed on 15, 13, 8, and 9 June in the four summers. They became common after mid-June, but the large non-breeding flocks did not appear until July. Maximum numbers recorded each year were 60 on 10 July 1966, 29 on 18 July 1967, about 150 on 18 and 19 July 1968, and about 60 on 15 July 1969. Numbers generally declined in late July and August, but on 8 August 1966 a flock of about 55 was seen on the Sparbo-Hardy Lowland. In 1967 none was seen on the Truelove Lowland after 16 August, but in 1968 three were seen as late as 22 August. The large flocks recorded in July 1968 and 1969 were apparently feeding on a very abundant supply of midges (Chironomidae) on the ice on the largest lake on the Truelove Lowland. Nearly all birds observed were in adult plumage. The only dark-plumaged immature jaegers seen, all believed to be of this species, were single birds, on 3 July 1966, 6 July 1968, and 24 June 1969.

Five nests were found on the Truelove Lowland in 1968 and three in 1969. There may have been one or two other breeding pairs on the lowland in those two years, but it was clear that the breeding population was small in comparison with the numbers of non-breeders. In one nest, laying was complete as early as 25

TABLE 4 — Food of young Parasitic Jaegers

Nest number and year	Description	Date(s)	Items identified
1/67	16+ pellets	25 July–5 August	2 Snow Buntings 4 unidentified Fringillids[1] 6 unidentified Scolopacids[2] 1 unidentified bird 2 bird eggs, probably *Somateria* sp. 1 Hymenoptera, *Bombus* sp. 1 small piece of moss
1/67	Crop and stomach of UMMZ No. 215,899	25 July	1 Snow Bunting 1 bird egg, probably *Somateria* sp.
1/68	Crop and stomach of UMMZ No. 215,918	13 August	1 lemming, *Discrostonyx groenlandicus* 13 Diptera, Muscidae 5 Lepidoptera (larvae) 1 Lepidoptera (adult)

[1]Lapland Longspur or Snow Bunting.
[2]White-rumped or Baird's Sandpipers.

June 1968, but the second egg in another nest was not laid until 30 June 1968. Three clutches known to be complete had two eggs each and the other five nests also contained two eggs when they were observed. Maher (1970) notes that clutch sizes on Ellesmere Island were of one or two eggs, the average clutch size being lower in poor lemming years. We obtained no evidence that young were hatched or raised successfully on Devon Island in 1968 or 1969. Eggs disappeared from at least four of the five nests in 1968 and it was believed that arctic foxes were responsible for some of these losses.

TABLE 5 — Crop and stomach contents of adult Long-tailed Jaegers

Date collected	Items identified
10 July 1966	2 Diptera, Tipulidae (adults) 1 Lepidoptera (larva)
11 July 1966	1 Diptera, Tipulidae (adult) 84 Lepidoptera (larvae) 2 Hymenoptera, Tenthredinidae (adult) 2 Araneida 2 feathers 1 piece of grass, a few small pieces of eggshell
13 July 1966	1 Lepidoptera (larva)
15 July 1966	Arthropod parts
4 July 1967	2 Hymenoptera, Tenthredinidae (adults) 1 bird egg, probably *Somateria* sp. 5 leaves of *Dryas integrifolia*

GLAUCOUS GULL. *Larus hyperboreus*. Glaucous Gulls were seen regularly in small numbers on the Truelove Lowland throughout the periods of our visits there each year, but away from the colonies we rarely saw more than five individuals in any day. About 100 were observed scattered over the Sparbo-Hardy Lowland on 19 August 1967, and on 15 August 1968 about 25 birds were seen flying over Jones Sound.

There was a breeding colony of about 15 pairs on the cliffs on the south side of Truelove Inlet. When this colony was first noticed on 1 July 1966 there were about 30 adults present and there appeared to be between 10 and 15 occupied nests. On 15 August 1967 the colony was examined more closely. The nest sites were on the steepest part of the cliff and proved to be inaccessible, but three broods of one, and three of two large young were present. On 8 August 1966 two other small colonies were noted on inaccessible cliffs between the Base Camp and the Sparbo-Hardy Lowland. There were 10 adults and at least four young at one of these colonies and six adults were present at the other. Eight pairs were present at the first of these colonies when it was visited again on 18 August 1967.

THAYER'S GULL. *Larus thayeri*. These birds are uncommon. Single birds were seen on 25 June and 2 July 1966; 19, 20 June and 22 July 1968; 26 June and 11 July 1969. Two were seen at the Base Camp on 7 July 1969. None was seen in the vicinity of the Glaucous Gull breeding colonies. Contrary to the distribution shown in Godfrey (1966) we found no evidence that Thayer's Gulls breed on this part of Devon Island.

IVORY GULL. *Pagophila eburnea*. This species was observed in Jones Sound by M. M. R. Freeman while he was crossing from Cape Sparbo to Grise Fiord, Ellesmere Island, on 25 and 26 June 1966. One or two were seen several times in early July 1969 by Dr. and Mrs. H. Simpson, and R. Tufft at their camp near the

shore northwest of our Base Camp. Single individuals were seen there by D. C. Smith on 3, 9, and 10 July.

BLACK-LEGGED KITTIWAKE. *Rissa tridactyla*. One was seen flying over Jones Sound by D. C. Smith on 9 August 1969.

ARCTIC TERN. *Sterna paradisaea*. Arctic Terns were late arrivals on Devon Island, appearing in numbers only after there was open water in the lakes and ponds. They were first seen on 21, 21, 24, and 17 June in the four years. Solitary pairs nested on raised beaches near the Base Camp and on rocks exposed above the shallows near the shores of some of the larger lakes. There were scattered colonies on the islands and shores of some of the small lakes near the coast. These colonies were examined closely only in 1967 when groups of 11 and 5 nests were found at two lakes.

Thirty-five nests were recorded in the four years. Of 22 clutches known to be complete 12 contained two eggs and 10 were of one egg, mean 1.54. The average of 18 clutches on nearby Bylot Island was 1.55 (Drury 1960). The earliest egg date was 1 July 1969 when a pair nesting near the Base Camp had one egg; a second egg completed the clutch the following day. Another pair on the same beach ridge had their first egg by 3 July 1969. Known or estimated dates of first eggs in other years ranged from 6 July until at least 3 August. In 1967 when dates of first eggs were known or could be calculated for 17 nests, 12 were laid between 9 and 16 July, four between 24 and 30 July, and one was laid sometime between 3 and 13 August. These late nests may have been repeat layings by birds which had lost previous clutches, and their chances of survival must have been very poor. The incubation periods for the second eggs in four clutches were about 21, 21½, 22, and 22 days; the single egg in another clutch was incubated for at least 21 days before it hatched. Newly-hatched young were found as early as 22 July in 1969 and as late as 22 August in 1967. Data on growth of the young, collected by Holroyd in 1967, will be published elsewhere. Many eggs and young disappeared and there was evidence that arctic foxes were the main predators.

The breeding season on Devon Island is remarkably late. It was no earlier on Bylot Island, however, where Drury (1960) thought that most egg-laying occurred between 11 and 18 July. On Fosheim Peninsula, Ellesmere Island, eggs were laid in early and mid-July (Parmelee and MacDonald 1960); and at Cambridge Bay, Victoria Island, from 19 June until early July and occasionally as late as mid-July (Parmelee et al. 1967). At Churchill, Manitoba, nesting starts in the third or fourth week of June (Jehl and Smith 1970; Evans and McNicholl 1972), and on Machias Seal Island, New Brunswick, most egg-laying takes place in early June (Hawkesley 1957).

A young tern banded on Devon Island on 7 August 1967, when it was about four days old, was found dead on 4 October 1967 at Bourgneuf Bay, France (47°00′ N, 1°50′ W). Allowing 23 days for fledging (Parmelee and MacDonald 1960), this bird could not have left Devon Island before 26 August and it took no more than 39 days to travel approximately 3000 miles.

An adult banded at the Base Camp on 1 August 1966, while attending recently hatched young, was trapped again at a nest in the same vicinity on 5 July 1969. In the summer of 1970 the wing of this bird was accidentally broken at a nest at the same place; it was killed and dissection showed that it was a male (J. Teeri, personal communication).

THICK-BILLED MURRE. *Uria lomvia*. Several murres were seen in flight over the sea on 9 August 1969. They were too distant for definite identification, but were assumed to be this species, in view of the known ranges of *U. lomvia* and *U. aalge* (see Godfrey 1966).

BLACK GUILLEMOT. *Cepphus grylle*. Several were seen in flight over the sea on 9 and 10 August 1969.

SNOWY OWL. *Nyctea scandiaca*. The presence of Snowy Owls was apparently linked to the abundance of lemmings. None was seen in 1966 or 1967 when lemming populations were relatively low (Table 2). In 1968 at least two different individuals were seen on several dates from 11 June to 6 July. In 1969 one or two were seen occasionally between 12 and 27 June. From then until we left the area in August, as many as four could be seen at one time on the Truelove Lowland, and possibly as many as six were present on some days. Although the increase in the numbers of Snowy Owls in our area in 1969 was associated with the highest lemming population in four years, there was no evidence that the birds were breeding.

HORNED LARK. *Eremophila alpestris*. A pair was seen on 21 June 1966 and single birds on 13 June and 6 July 1966, 22 June 1967, 13 and 22 June 1968, and 27 June 1969. In three cases in which the birds were closely observed they had the whitish eyestripe characteristic of *E. a. hoyti*. There was no evidence of breeding in the area.

COMMON RAVEN. *Corvus corax*. One or two individuals were seen regularly on the Truelove Lowland and in Truelove Valley. We also recorded Ravens on the Skogn and Sparbo-Hardy Lowlands. There was no definite evidence of breeding in the area, but it was thought that young birds were present in parties of three to six Ravens seen in July or August each year.

WHEATEAR. *Oenanthe oenanthe*. One, probably a male, was seen by G. W. Page near Truelove Inlet on 19 July 1968.

LAPLAND LONGSPUR. *Calcarius lapponicus*. Longspurs were common breeders on the Truelove Lowland, being more abundant in 1966 and 1967 than in the following two years. Clutch size and some other aspects of the breeding of this species on Devon Island have been discussed in more detail elsewhere (Hussell 1972).

Males tended to arrive slightly ahead of the females: the first were noted on 15, 12, 7, and 12 June in the four years. Within a few days after the first birds arrived the song flights of the males were a common occurrence, females were present, and nesting activities were getting under way. Eighty-two nests were found in the four years. Most consisted of a depression, lined with grasses and feathers, in the side of a small hummock or sometimes beside a rock, and protected to some extent by the surrounding low vegetation. They were found in a variety of sites including grassy hummocks in the wet meadows, peaty ice-wedge polygons, and among clumps of *Dryas integrifolia* on the exposed slopes of the raised beaches. In 1966 and 1967 the majority of the 54 nests recorded were within about a mile of the Base Camp. In the following two years the breeding population in this area was much reduced, perhaps partly because of the later melt, and most of the 28 nests found were in other parts of the lowland.

A female was seen carrying nesting material to a nest site as early as 15 June in 1967 and the first egg was laid in this nest on 18 June. The peak period for starting clutches extended from 20 June to 5 July. There were a few late clutches: in 1967 one clutch was estimated to have been started as late as 12 July. Clutch size ranged from two to seven eggs, with a mean of 5.04 eggs for 54 clutches known to be complete. The first newly-hatched young were recorded on 4 July 1967 and the latest young was still in the nest on 1 August 1967 and 1969. Song was much reduced by 10 July each year and was almost absent a week later.

Nesting success was low. In only 14 of the 82 nests were young known to have been raised to the nest-leaving stage; 63 nests were lost to predators, three were deserted probably as a result of our activities, one clutch was entirely infertile, and the fate of one brood was not known. The scarcity of unbanded fledged young (from nests we had failed to locate) confirmed that breeding success was generally low. Arctic foxes were thought to be responsible for most of the predation, but other predators, including Parasitic Jaegers and weasels may have been involved.

In late July and August the adults underwent a complete molt, and they and the young were present each year until we left the area.

At least some adults returned to the Truelove Lowland in successive years. Twenty-two adults were banded in 1966, 1967, and 1968 (1, 14 and 7, respectively). In 1967 and 1968 birds were individually marked with colored bands as well as a numbered aluminum band. One male, banded on 14 July 1967, was seen in the same vicinity on 19, 22, and 25 July 1968. A female, banded at a nest in 1967, returned in 1968 and nested about $1^1/_2$ miles from the 1967 site. Another female, banded at the Base Camp on 11 August 1967, returned on 22 June 1968 and subsequently nested about $^1/_4$ mile north of the Base Camp. None of 56 young Lapland Longspurs, banded 1966–1968, was seen in subsequent years.

SNOW BUNTING. *Plectrophenax nivalis*. Snow Buntings were common breeders on the Truelove Lowland. They were one of the few species that were also seen occasionally at altitudes over 1000 feet during our trips on the plateau. Buntings were present on Devon Island at the time of our arrival each year, although apparently newly-arrived birds continued to move into the breeding areas at least until the third week of June. In 1969 R. Tufft reported that the first Snow Bunting was seen on 15 May.

One hundred and two occupied nests were found in the four summers. Most nests were in fissures in boulders or rock outcrops, under boulders lying on the ground, or in piles of ice-push boulders along the shores of the three largest lakes on the lowland. Nearly all of the nests were easily accessible, but in some cases rocks had to be moved to reach them. Only one was in an artificial site—under a piece of plywood lying on the ground at Base Camp. The distribution of breeding birds was partly related to the availability of suitable nest sites, but in 1968 and 1969 fewer nests were found in the immediate vicinity of the Base Camp than in the previous two years. As was the case with the Lapland Longspur, the distribution of breeding pairs may have been affected by the timing of the melt in different years.

A female was seen carrying material to a nest site on 16 June 1969 and the first egg was laid in this nest on the following day, the earliest egg-laying date we recorded. Most clutches were started between 20 and 30 June, with a few late clutches in the first week of July. The two latest clutches were estimated to have been started on 7 July in 1967 and 1968. Clutch size varied from four to seven eggs (one clutch of two eggs) and averaged 5.25 eggs in 69 clutches known to be complete. The first newly-hatched young were recorded on 3 July 1969 and the latest date on which young were still occupying a nesting cavity was 4 August 1967. Some aspects of the breeding biology of this species have been reported in more detail by Hussell (1972).

Although Snow Bunting nests are built in much better protected sites than those of Lapland Longspurs, predation was remarkably heavy. In 1968 and 1969 we protected many bunting nests which we wished to use for experimental purposes by placing rocks around the entrances to the nest cavities to make them inaccessible to arctic foxes. Of 36 nests observed in 1966 and 1967, 19 were taken by predators, two were deserted, young were raised to fledging in 14, and the fate of one was unknown. Protection of nest sites in 1968 and 1969 resulted in improved success, and young were fledged from at least 30 of 66 known nesting attempts. Arctic foxes were thought to be mainly responsible for the losses but in 1969 at least two experimental broods were taken by weasels.

In July and August the adults undergo a complete and rapid molt. During the height of the molt some adults are almost flightless at a time when the young are flying well, and they often hide in rock crevices on being approached, rather than fly away. Both adults and young were present on the Truelove Lowland until the time of our departure each year.

Some adults returned to nest on the Truelove Lowland in successive years. Thirty-two adults were banded with numbered aluminum bands in 1966, 1967, and 1968 (1, 13, and 18, respectively), and in 1967 and 1968 the birds were also individually marked with colored bands. One female, which nested among ice-push boulders along a lake shore about a mile south of the Base Camp in 1967, returned and nested near Truelove Inlet in 1968. A male attended nests in the outcrops about a mile east of the Base Camp in 1968 and 1969. Another female nested among the same ice-push boulders mentioned previously in both 1968 and 1969, and was reported nesting in the same area in 1970 and 1971 (D. L. Pattie, personal communication). This Snow Bunting was at least four years old in 1971. None of the 135 young buntings banded 1966–1968 was seen in subsequent years. A pellet (probably from a jaeger) found by D. L. Pattie in 1971 contained a band from a young bunting fledged in 1969, but the age of the pellet is unknown.

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Notes

Observations on Bird Singing during a Solar Eclipse

Abstract. The change in the rate of bird singing during the passage of the total solar eclipse of July 10, 1972, was observed at one location in Nova Scotia. The warbler species essentially stopped singing during totality; the sparrow species appeared to sing at a normal rate. But the diurnal response to light intensity is similar for these two groups. For a number of species an increased singing rate in response to the falling light intensity before totality, which may be compared with an approaching evening, is evidence of some exogenous control.

Introduction

On July 10, 1972, a total solar eclipse cast a swiftly moving, 180-kilometer-wide shadow along a route that travelled from eastern Asia, across Alaska and Canada, and on into the Atlantic. In its path thousands of birds representing hundreds of species were faced with a 'decision.' The normal routine of sunrise, noon, sunset was broken when the light intensity suddenly dropped to a nighttime level and continued so for slightly more than two minutes. A typical comment summarizing the observed response during previous eclipses is "the birds stop singing."

The authors had an opportunity to witness the eclipse as it passed through Nova Scotia in the mid-afternoon. We decided to make the rate of bird singing one of our observations. The following is an account of our findings.

After some searching, trying to avoid the extensive cloud cover, we picked as a promising perch a hillside near Malignant Cove, overlooking the Northumberland Strait. Our position was near the center of the path of the eclipse, with totality due to arrive at about 1637 Atlantic Standard Time, and to last for approximately 127 seconds (details of the eclipse can be found in an article by Smiley (1971)). We were located about 1 kilometer from the water's edge. Surrounding us were fields of a bygone day spottily overgrown with tall clumps of spruce. Half-way down the hill the trees and clearings gave way to the grassy meadows that stretch along the ocean shoreline. Two kilometers to the southwest along the coast lay the village of Malignant Cove, nestled beside a thickly wooded creek. The day was still and hot with temperatures in the mid 20's (°C) (near 80°F) and winds averaging about 3 meters per second. Despite the cloudiness ($^6/_{10}$ Cumulus and $^4/_{10}$ Cirrus), conditions at totality proved to be nearly perfect.

We had arrived at the site in good time and had set up our telescope and begun recording numbers of bird songs about 2 hours before totality.

Methods

The passage of an eclipse is marked not only by an extreme change in light intensity (of about 5 orders of magnitude) but also by other ground-level effects associated with the shadow, such as a small change in air temperature or atmospheric pressure. We considered these additional effects to be of secondary importance. Thus, to follow the eclipse, from the avian point of view, we kept track just of light intensity along with the rate of singing.

The pattern of our observations was to note verbally on a tape recorder all bird songs, identified as to species, that were heard during a 3-minute period. This was repeated every 15 minutes from 1½ hours before totality until 1½ hours after. Recordings were made continuously during totality and for a few minutes before and after. No attempt was made to estimate the number of individuals that were singing within hearing range; in most cases it appeared to be limited to a few of each species. We kept track of time using a wristwatch with a sweep second-hand. Background noise, which came mainly from traffic on the shore road about half a kilometer away, was relatively constant and only occasionally increased to a level that made hearing difficult.

Light intensity was measured using a photographer's light meter. Those who have experienced a total eclipse realize that a few seconds immediately before or after the shadow, intensity levels are more nearly like that experienced when a dark cloud passes in front of the sun. It is only within the shadow that there is a nighttime sensation. Accurate measurement of the daytime totality-range requires a much more sophisticated instrument than our light meter; nevertheless, our readings are sufficiently accurate to cover times up to a few seconds on either side of totality. The meter has a scale calibrated in foot-candles; this is the unit we used. To take a reading the meter was held so that the sensing element was exposed vertically, providing an integrated measure of the incoming sun- and sky-light. The meter was read in conjunction with each 3-minute observation period.

A measure of the light intensity within totality itself can be taken from values for previous eclipses since it does not vary significantly. The intensity is typically about 0.1 foot-candle (Mitchell 1932). According to B. Paton, Dalhousie University (personal communication), this eclipse was slightly brighter than normal, 0.2 to 0.4 foot-candles being a more likely level, essentially constant

TABLE 1 — Bird singing rates before, during, and after total solar eclipse, July 10, 1972

	Time										
	1510–1514	1541–1545	1600–1604	1614–1618	1627–1631	1635.6-1637	1637–1639	1639–1645	1653–1657	1707–1711	1722–1726	1740–1744
Radiation (foot-candles)	1500	1500	1400	800	500	60	Totality	4 to 500	600	400	640	1000
Sun covered, %	0	10	45	65	85	95	100	95	75	50	25	0
Yellow Warbler *(Dendroica petechia)*	— 3 4	— — —	— 2 2	2 — —	1 — —	5	— —	5 6 7 2 3 4	2 1 3	— 8 3	— — —	— — —
Magnolia Warbler *(Dendroica magnolia)*	— — —	— — —	— — —	2 5 6	5 1 1	—	— —	— — — — — —	— — —	2 — 1	1 — 2	— — —
Common Yellowthroat *(Geothlypis trichas)*	4 3 1	— — 3	11 5 4	2 2 1	2 — 3	—	— 1	6 1 3 1 — 2	3 3 —	5 2 3	2 3 1	— — —
Red-winged Blackbird *(Agelaius phoeniceus)*	— 1 —	— 3 —	1 — —	2 — 3	1 — 1	3	— 1	1 1 — — 2 3	2 4 —	6 — 1	4 6 2	2 — 1
Chipping Sparrow *(Spizella passerina)*	4 2 1	— 1 —	1 — —	— 1 1	— — 3	—	1 1	— — 1 — — 1	— 1 —	— — —	— — —	1 — —
Song Sparrow *(Melospiza melodia)*	5 4 3	8 11 8	5 5 5	6 6 5	1 6 9	4	3 8	2 2 1 5 4 2	1 3 1	1 3 1	2 1 4	3 3 3
Total, all species	13 21 15	22 19 13	20 14 18	16 19 17	16 13 20	14	4 16	14 15 12 8 9 13	12 15 5	16 15 11	12 12 12	8 8 5

during the 127 seconds of totality. These levels are about equivalent to those measured under a clear sky 30 minutes after sunset or at night with a half moon.

Observations and Conclusions

The songs heard during an observation period were tallied as total songs for each species per minute of listening time. A total of 17 different species, consisting mainly of warblers and sparrows, were identified by song. The most vociferous species are listed in Table 1 by common name, the reference being Godfrey (1966). Each column lists the total number of songs heard in a given period. The time interval is approximately 60 seconds in all cases except one, the exception being of 82-seconds duration just before totality. Totality, which actually lasted for about 127 seconds, was arbitrarily taken to be two 1-minute intervals.

Normal Singing Rate versus Eclipse Singing Rate

Four species, Yellow Warbler, Common Yellowthroat, Red-winged Blackbird, and Song Sparrow, were the only persistent singers during our observation periods, and together they account for almost three-quarters of the songs heard. The total number of songs per minute of observation is given in the last row of Table 1. We had an overall average of about 14 songs per minute with a minimum of four and a maximum of 22. This minimum of four songs per minute occurred during the first minute of totality! A one-tailed level of significance test for the four songs-per-minute rate is 0.01; that is, there is a probability of one in 100 that the observed rate could have occurred by chance. To perform this test it is assumed that all observations other than during totality represent a normal background; that is, without other influences such as the diurnal cycle, a reasonable assumption, except perhaps for the last observation period. Thus the song rate during the first half of totality was reduced 'significantly'; the same cannot be said for the latter half. A closer examination shows that this result is not true for each species.

Instead of considering each species in turn, there is a pattern that can be seen by grouping separately the two major contributors, the warblers and the sparrows. These two groups have a sufficient number of songs to provide a reliable background level with which to compare the song rate during totality. The totals for warblers and for sparrows are plotted in Figure 1A and B respectively. An observation period is depicted by a thickening of the

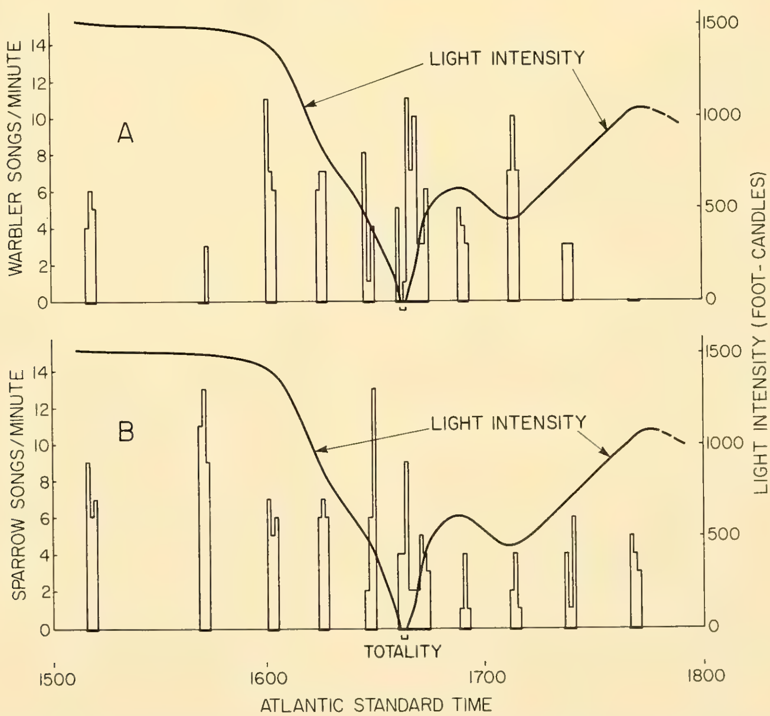

FIGURE 1. The total number of (A) warbler and (B) sparrow songs heard per minute of observation period on the afternoon of the eclipse. Each 3-minute observation period is indicated by a thickening of the abscissa. The solid line represents the measured light intensity.

abscissa or time axis. A continuous curve for light intensity level portrays the passage of the eclipse. (The dip in radiation intensity near 1710 AST is due to cloud cover.) The graphs of Figure 1 illustrate that during totality the sparrows sang at a near-normal rate, apparently unaffected by the change in light intensity, while the warblers definitely reduced their singing rate; only one warbler song was heard during totality, compared to an average rate of six songs per minute. There are other examples in the data where no warblers sang during a 1-minute observation period; however, for almost 1 hour before or after totality this is not true. In spite of the good correlation with totality, the level of significance, using all the data for warblers, is about 0.15; that is, there is a 15% probability that the low level of warbler singing (a single warbler song) during totality is accidental. The level of significance is much smaller if only the data three-quarters of an hour on either side of totality are used.

Not only did the sparrows sing at a near-normal rate during totality but another species, a flycatcher, increased its rate for totality. The other totality singers, the Spotted Sandpiper, Common Crow, and Red-winged Blackbird, did not have a sufficiently high or low 'normal' song rate to distinguish totality from normal. (Nevertheless, they appeared to be unaware that diurnal species are not supposed to sing during a total solar eclipse.)

Ehrström (1956) compiled the results of a study done in conjunction with the June 30, 1954, total eclipse in Sweden. The Swedish totality was of similar duration to the one for our observations; most of the data are for Old World warblers (Sylviidae), finches, and thrushes. His general conclusions are that all diurnal species stopped singing and nocturnal ones commenced singing during totality; in fact, he observed that diurnal species actually did not sing from a few minutes before until a few minutes after totality. Our general conclusions are different in that we heard seven diurnal species singing during totality, particularly the vociferous Song Sparrow. Even the North American wood warblers (Parulidae), for which only one song was heard during totality, had a high song rate immediately before and immediately after totality (see Figure 1A).

Diurnal Cycle versus Eclipse Cycle

The most popular approach to explaining the bird behavior observed during the passage of an eclipse is to draw a parallel to the normal diurnal rhythm (see for example, Welty 1962). Examination of this daily pattern has revealed characteristics of endogenous control (internal clock) as a coarse timepiece. In addition, birds have been observed to have a striking awareness of specific levels of light intensity by which they time some of their daily activities, such as the beginning of morning singing. To keep pace with seasonal or latitudinal variations in the solar day, birds are, of necessity, capable of shifting the phase of their activities. When confronted with a solar eclipse that produces a 2-minute 'night' completely out of phase with the anticipated change in light intensity, however, a well organized response can be expected only if strong exogenous control overrides the internal clock.

One study of the normal diurnal cycle that is relevant to this comparison of singing rate with light intensity is the one by Leopold and Eynon (1961). They correlated light intensity with the first and last songs of the day. Fortuitously the time of year, June–July, and a number of the species monitored, Eastern Wood Pewee, American Robin, Common Yellowthroat, Red-winged Blackbird, and Chipping, Field, and Song Sparrows, are similar to those in the present study. For all these species, typical values are 0.01 to 0.05 foot-candles for the first song in the morning and 0.2 to 10 foot-candles for the last song in the evening. When these values are compared with 0.2 to 0.4 foot-candles, the light intensity of the totality, a reason for uncertainty, even in the case of strong exogenous control, is evident. If the diurnal species monitored during the eclipse were behaving in a very mechanistic way there is the dilemma that the intensity during totality is low enough to turn them off, but not low enough to keep them off.

Our observations show a mixture of responses. The warblers' song rate adjusted with a believable correlation to the change in light intensity resulting from totality; the sparrows' song rate did not. As indicated in the above paragraph, however, in the normal daily pattern the warblers and sparrows have roughly the same response to changing diurnal light intensity.

Many species have a habit of singing at a higher rate in the morning and evening and lower at mid-day. A period of falling light intensity similar to that of approaching evening occurs before the eclipse (see Figure 1). There is some evidence in the present data that this drop in light intensity triggered an increased singing rate. In some cases, near the end of our observation period, late afternoon, the normal increased rate was observed. The species showing this response to the eclipse are the flycatcher, Barn Swallow, American Robin, Magnolia Warbler, and White-throated Sparrow. This behavior also suggests exogenous control. A morning type of response after the eclipse would not be expected because the birds would not have adjusted to nighttime activity in 2 minutes, and the change from totality conditions is sudden rather than gradual.

Both the sudden cut-off of singing by the warblers and the increased singing by some species during the falling light intensity before the eclipse do suggest a parallel to the normal diurnal cycle through exogenous control. But as is definitely shown by the number of songs, particularly Song Sparrow songs, heard during totality, all diurnal species do not necessarily cease singing during a total solar eclipse.

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Adder's-tongue Fern, *Ophioglossum vulgatum* L., in Northwestern Ontario

Abstract. A general discussion of the Ontario distribution of *Ophioglossum vulgatum* L. is given in relation to the first collection of this species in the Thunder Bay District, northwestern Ontario. The population is located in a flush area on Mount McKay. The special local climate and enriched soil of the flush has resulted in a rich flora (86 species in 0.11 km²), which contains a number of species more characteristic of regions to the south.

Adder's-tongue fern, *Ophioglossum vulgatum* L. var. *pseudopodum* (Blake) Farwell, was first collected in northern Ontario in 1873, at Rainy River by G. M. Dawson. This collection by Dawson is the most westerly in Canada, as Scoggan (1957) and Boivin (1967) do not report this species from Manitoba or the adjacent Prairie Provinces, and *O. vulgatum* is absent even in British Columbia, although it is present in the state of Washington (Taylor 1970)*and also in Alaska (Hultén 1968). In northern Ontario, in addition to the Dawson record, *O. vulgatum* has been collected at Timagami; at Lanark Lake (Cochrane District) in 1954 by Baldwin (1958); at Agate Bay in 1966 by Soper; and has been reported from Quetico Provincial Park by Walshe (1972). While it is not common in southern Ontario and adjacent Quebec (Marie-Victorin 1964), a number of records have been made including mass occurrences in the Ottawa District (Greenwood 1967). The first collection of *O. vulgatum* for Thunder Bay District was made in 1967 (P.B.-E. No. 1553 held at Lakehead University). This first record for the district was reported by Hartley (1968). *Ophioglossum vulgatum* is absent in nearby Cook County, Minnesota (Butters and Abbe 1953), but Tyron (1954) and Lakela (1965) list it in northern Minnesota although not within 150 kilometers of the Ontario border. Also, Hagenah (1966) and Wagner (1971) show adder's-tongue fern as not yet collected from nearby Isle Royale in northern Michigan.

The 1967 Thunder Bay record was of interest because of the rarity of the species in the area, and therefore some studies of this population were undertaken in the period May to September 1969 (G. V. Hess. 1970. Description of a unique flush community on Mount McKay. B.Sc. thesis, Lakehead University, Thunder Bay, Ontario. 66 pp.). The population is located on the south side of Mount McKay (48°20′ N, 89°15′ W), Fort William Indian Reserve No. 52, at an elevation of about 340 meters (1100 feet).

The immediate locale is a small unique flush area about 75 meters by 15 meters in size. The area is in a valley sheltered by cliffs and steep inclines of 70 to 120 meters on three sides and fully open only to the east, facing Lake Superior. Casual phenological observations indicate a warmer-than-normal local climate in the enclosed area. This is borne out by some of the vegetation of the valley. A number of species not common in the Thunder Bay area are found here, such as *Equisetum variegatum* and *Botrychium dissectum* in the flush area, and *Rhus radicans* and *Parthenocissus quinquefolia* on nearby dry south-facing slopes. Just to the west of the flush area is possibly the most northerly stand of *Acer saccharum* in the Thunder Bay area, which has as part of its herb layer *Polystichum braunii*. The vegetation generally is part of the transition zone between the Boreal Forest and the Great Lakes – St. Lawrence Forest. Because the area is ecotonal and because there is great topographical variation (from vertical cliffs to valleys) near the study area,

*O. vulgatum has been collected on Vancouver Island (personal communication from T. M. C. Taylor).

quite a number of communities are present. Common tree species are *Populus tremuloides, P. balsamifera, Acer spicatum, Abies balsamea, Picea glauca, Pinus divaricata,* and *Pinus strobus.*

The surrounding slopes alter the local climate and they also provide the drainage area for the water that constantly moves through the flush area. The water itself is provided by the rather evenly distributed precipitation of about 7–10 centimeters per month during the growing season, out of an annual precipitation of 76.5 centimeters. The nutrient enrichment is a leachate from surrounding soils, and nutrients from the shale that makes up part of the Mount McKay mesa. The mesa is composed of hard diabase sills and softer shales; the decomposed shales, which have readily available nutrients, form the clay fraction of the soil. The soil of the flush area is immature and has a thin layer of poorly developed humus on the top, underlain by a fine light brown clay. Chunks of shale of various diameters are mixed with the clay. Ninety-two soil samples show the mean pH to be 6.3 and the mean organic content to be 13.0%.

Obvious signs of man-made disturbance are present. There is a well-used trail leading to the top of the mountain and traversing the flush area. The trail is used for foot travel in the summer and for snowmobiles in the winter. There is also the remains of an old corduroy road under part of the east end of the flush area. Apparently a road went through the whole flush area at one time. This road may have been used for purposes of logging and also perhaps for quarrying, as blasting has taken place in some of the surrounding rock areas. Therefore disturbance has taken place in the past and is continuous up to the present.

A quadrat 75 × 15 meters was established in the flush area and systematically investigated to establish cover and distribution of vascular plants and bryophytes. A total of 86 vascular plants and 11 bryophytes was recorded. The species encountered are as follows, with the vascular plants according to Fernald (1950), and the bryophytes according to Watson (1968); a number of adventives were present and are indicated with an asterisk (*): Bryophytes—*Tortella tortuosa, Mnium cuspidatum, M. medium, Aulacomnium palustre, Climacium dendroides, Thuidium delicatulum, Hygroamblystedium* sp., *Drepanocladus revolvens, Heterophyllium haldanianum, Marchantia polymorpha,* and *Blasia pusilla*; Vascular Plants—*Equisetum arvense, E. hyemale, E. variegatum, Botrychium dissectum, B. virginianum, Ophioglossum vulgatum, Osmunda claytoniana, Pteretis pensylvanica, Onoclea sensibilis, Athyrium filixfemina, Abies balsamea, Typha atifolia, Glyceria striata, Poa saltuensis, Calamagrostis canadensis, *Agrostis scabra, *Phleum pratense, *Muhlenbergia mexicana, Scirpus rubrotinctus, S. atrocinctus, Carex stipata, C. bebbii, Juncus tenuis, J. brevicaudatus, Lilium philadelphicum, Clintonia borealis, Streptopus roseus, Habenaria hyperborea, Salix lucida, S. rigida, S. discolor, Populus tremuloides, P. balsamifera, Betula papyrifera, Alnus crispa, A. rugosa, Asarum canadense, Stellaria longifolia, *Ranunculus acris, Aquilegia canadensis, Cardamine pensylvanica, Parnassia palustris, Ribes hirtellum, Pyrus decora, Amelanchier spicata, Fragaria vesca, Geum aleppicum, G. macrophyllum, Rubus parviflorus, R. idaeus, Prunus pensylvanica, *Trifolium hybridum, Acer spicatum, Impatiens capensis, Parthenocissus quinquefolia, Viola selkirkii, V. pallens, V. incognita, V. renifolia, Epilobium angustifolium, E. glandulosum, Circaea alpina, Aralia nudicaulis, Osmorhiza obtusa, Cornus stolonifera, Mertensia paniculata, *Plantago major, Galium triflorum, Diervilla lonicera, Sambucus pubens, Solidago missouriensis, S. canadenis, S. graminifolia, Aster macrophyllus, A. puniceus, A. lateriflorus, A. umbellatus, *Erigeron philadelphicus, Anaphalis margaritacea, Achillea millefolium, *Chrysanthemum leucanthemum, Cirsium muticum, *Sonchus arvensis, Lactuca biennis, Prenanthes alba,* and **Hieracium florentinum.*

In the quadrat *Salix* spp., *Alnus* spp., *Diervilla lonicera,* and *Rubus parviflorus* are the dominant shrubs. The major herb species is *Equisetum arvense* with the important bryophyte species being *Marchantia polymorpha* and *Mnium* spp.

Ophioglossum vulgatum is present in seven stands well distributed through the flush area (for distribution map see Hess (1970)). There are at least 70 individuals, of which at least 47 were bearing sporangia. Probably more plants are present too, as *O. vulgatum* is very inconspicuous and the herbaceous vegetation in the flush area is very dense.

Finally, there is a significant population of adder's-tongue fern on Mount McKay but its future is not completely certain because of the proximity of the population to a well-used trail. It is hoped, however, that this interesting community is able to persist into the future.

We thank The Fort William Indian Band for their co-operation during the course of this study, Mr. D. R. Lindsay for noting and indicating the adventive species in the plant species list, Mr. C. E. Garton for bryophyte determinations and assistance with some vascular plant determinations.

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Blackpoll Warbler on Cornwallis Island, Northwest Territories

On 23 May 1971 a female Blackpoll Warbler, *Dendroica striata* (Forster), was observed near the laboratory of the Char Lake Project at what is known as the "South Camp" at Resolute Bay, Cornwallis Island, Northwest Territories, 74°41′ N, 94°53′ W. The bird appeared to be exhausted, and periodically sat with its head under its wing for several seconds. It was possible to approach the bird quite closely and several 35-millimeter color slides of it were taken. An attempt was made to capture the bird by advancing forward when it put its head under its wing, and I was able to approach within a foot of it. Unfortunately as I was about to grasp the bird in my hand a noise from another member of the party frightened it, and it flew behind some buildings. A thorough search of the area was to no avail and the bird was not seen again.

Snyder (1957) states that this species is characteristically subarctic and only rarely occurs much farther north than the tree-line. He notes a sighting recorded from the lower Firth River in the Yukon and a nesting record at Tununuk, north of the tree-line in the Mackenzie Delta.

Godfrey (1966) states that the species breeds as far north as Old Crow in the Yukon, the northern Mackenzie Delta, Fort Anderson, Artillery Lake, and the Thelon River in the Northwest Territories; Churchill, Manitoba; Fort Severn in northern Ontario; northern Quebec and Labrador. The American Ornithologists' Union (1957) lists the species as "accidental in Greenland," having been recorded at Narssarmiut, Godthaab, and Isua.

This sighting on Cornwallis Island would therefore appear to be the northernmost occurrence of this species to date, since it is several hundred miles north of any previous record.

I thank Dr. J. D. Rising for his help in identifying this species and for encouraging me to publish this record. Thanks are also due to Doctors W. E. Godfrey of the National Museum of Natural Sciences, J. C. Barlow and R. O. James of the Royal Ontario Museum, who identified the bird as a female Blackpoll Warbler from the color slides I had taken.

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Breeding Range Extension of the Acadian Flycatcher

The discovery of a nest of the Acadian Flycatcher (*Empidonax virescens*) on Sideline 26, Pickering Township, Ontario County, constitutes the first definite breeding record for the species north of Haldimand County. A hanging nest, constructed of grass and lined with dry leaf midribs, was found on 9 July 1973. The nest was positioned about 2.5 m from the bole of a sugar maple (*Acer saccharum*) and 3 m from the ground. (This nest is now specimen number 11440 in the Royal Ontario Museum.) The female (presumed from lack of song) was observed sitting on the nest for periods of 5 to 10 minutes on 9 July and 11 July, but the single egg was not laid until 12 July. Hatching occurred on 26 or 27 July and the chick had fledged by 2 August, when the male was observed feeding it.

Although the Acadian Flycatcher cannot be distinguished from other eastern *Empidonax* species by sight, its song is immediately distinguishable. The male of this nesting pair sang frequently and was immediately recognized as being of this species when first heard on 31 May 1973. In addition, the Acadian Flycatcher is the only *Empidonax* species which builds a nest suspended in the fork of a branch.

W. E. Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.) states that the Acadian Flycatcher has been recorded without evidence of breeding at Toronto. The northernmost previous breeding record is at Dunnville on Lake Erie (Ontario Nest Records Scheme). A nest of the species (no observation of breeding), however, was seen by E. Pegg (personal communication) in Uxbridge Township, Ontario County, in 1966.

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Vertebral Frequencies with Notes on Anomalies in Samples of Threespine Sticklebacks (*Gasterosteus aculeatus* L.) from Eastern North America

Abstract. Samples of the threespine stickleback *Gasterosteus aculeatus* taken from Baffin Island south to Cape Cod in eastern North America were examined for vertebral number and for vertebral fusion. There was no evidence for clinal variation in vertebral number, and vertebral number could not be associated with types of habitat. Vertebral fusions are reported for the first time in eastern Atlantic populations of *G. aculeatus* and were noted also in the discrete Pacific populations of the species complex. Other eastern North American sticklebacks, *Apeltes quadracus* and *G. wheatlandi,* also had fused vertebrae in some individuals. Adverse temperature during ontogeny is suggested as a major factor causing vertebral fusion.

The threespine stickleback is found in coastal and fresh waters of eastern North America from Baffin and Devon Islands south to Chesapeake Bay. It occurs across Europe and Russia and on the Pacific coast of North America (McPhail and Lindsey 1970).

Radiographs of 27 samples, drawn mainly from the collections of the National Museum of Canada, were examined for total vertebral number (Table 1) and for evidence of vertebral fusion (Table 2). The urostyle was counted as one vertebra. Further details of the samples are on file at the National Museum of Canada, Ottawa.

Vertebral numbers fall within the ranges recorded by Garside and Hamor (1973) for samples from a more limited area in eastern Canada. Their counts of vertebrae did not include the urostyle. Analysis of variance indicates that the major differences observed between the populations are statistically significant. No clinal variation in vertebral number was evident. Vertebral number could not be associated with pelagic or fluvial habitats as determined from capture data (Hagen and Gilbertson 1972). Without more detailed knowledge of migrations, however, this conclusion must remain tentative. Garside and Hamor (1973) consider temperature as an important environmental variable affecting vertebral number during ontogeny. It is pertinent to note that samples NMC 59-398 and NMC 59-433 have significantly different vertebral counts ($P < 0.05$) although their provenance is very close (Table 1). The temperature regimes in a small pool compared to a lake may be quite different, and this lends support to the contention of Garside and Hamor.

Seven samples contained from one to three individuals with fused vertebrae (Figure 1). Types of fusion included partially discrete and indistinguishable fusions of centra and some fusions of haemal and neural arches. These specimens were not included in the total vertebrae counts. The position of the fused vertebrae in the vertebral column is summarized in Table 2. Two samples of threespine sticklebacks from the Pacific coast of North America were examined for comparative purposes. One individual (NMC 59-90) from a sample of 24 taken in Bertrand Creek, British Columbia had vertebrae 12–14 fused. One individual (NMC 61-85) from a sample of 29 taken in Prince William Sound, Alaska had vertebrae 14–15 fused. Fused vertebrae are thus common to the discrete American Atlantic and Pacific populations.

Other species of sticklebacks in eastern North America have fused vertebrae. A sample of the blackspotted stick-

TABLE 2 — Position of fused vertebrae in threespine sticklebacks of eastern North America. Table 1 has location details. (A = abdominal vertebrae; C = caudal vertebrae.)

Collection	Standard length, mm	Fused vertebrae
NMC 66-177	49	18–19, 20–21 C
NMC 67-160	56	24–26, 32–33 C
,,	55	27–28 C
Matamek River, Québec	62	26–27 C
NMC 60-223	54	8–10 A
NMC 64-862	35	17–18 C
,,	32	23–25 C
,,	28	26–27 C
NMC 58-324	43	18–20 C
NMC 65-335	44	14–16 C

TABLE 1 — Total vertebral numbers in samples of the threespine stickleback from eastern North America. Samples are listed from north to south. (F = freshwater sample; M = marine sample; NMC = National Museum of Canada collection number.)

Collection number	Location	Habitat	Standard length, mm	Number	Total vertebrae: Range	Mean	Standard error
NMC 67-150,	N.W.T., Baffin Island, Nettilling Lake 66°30′ N, 70°40′ W	F	39–48	6	32–33	32.33	0.21
NMC 60-278, 60-280,	N.W.T., Baffin Island, Lake Harbour 62°51′ N, 69°53′ W	F	41–55	3	31–32	31.66	—
NMC 59-398,	Québec, Ungava Bay, Bobs Lake 59°00′ N, 66°15′ W	F	35–55	11	31–33	31.64	0.20
NMC 59-433,	Québec, Ungava Bay, pool near Bobs Lake 59°00′ N, 66°15′ W	F	35–55	37	32–34	32.35	0.09
NMC 58-356,	Québec, Ungava, Lake Canichico 56°47′ N, 68°51′ W	F	37–57	29	32–34	32.59	0.11
NMC 60-79,	Labrador, lake north of Nain ca 56°43′ N, 61°38′ W	F	33	1	33	33	—
NMC 63-226,	Québec, Hudson Bay, Charr Lake 56°21′ N, 76°29′ W	F	25–49	18	31–33	32.00	0.11
NMC 67-160,	Québec, Hudson Bay, Richmond Gulf. 56°13′ N, 76°20′ W	M?	43–66	32	31–35	32.88	0.13
NMC 69-379,	Labrador, Sandgirt Lake 53°52′ N, 65°17′ W	F	30–49	3	33–34	33.33	—
NMC 66-177,	Newfoundland, brook into White Bight 51°36′ N, 55°53′ W	F	37–56	49	31–33	31.96	0.07
NMC 60-76,	Québec, Belle Isle Strait 51°25′ N, 57°08′ W	M	60–62	2	32–33	32.50	—
	Québec, near Sept Iles, Matamek Lake 50°22′ N, 65°54′ W	F	30–49	46	32–34	32.85	0.08
	Québec, near Sept Iles, Bill Lake 50°21′ N, 66°07′ W	F	31–49	34	30–33	32.00	0.11
	Québec, near Sept Iles, Matamek River 50°17′ N, 65°58′ W	F	48–74	39	31–34	32.48	0.12
	Québec, near Sept Iles, Amory Cove 50°17′ N, 65°57′ W	M	35–74	68	31–34	31.86	0.09
NMC 60-223,	Québec, Rimouski River 48°27′ N, 68°32′ W	F	46–59	54	32–34	32.82	0.07

TABLE 1 — (*Continued*)

Collection number	Location	Habitat	Standard length, mm	Number	Total vertebrae: Range	Mean	Standard error
NMC 71-54,	New Brunswick, Burnt Church River 47°13′ N, 65°07′ W	F	46–61	12	30–34	31.77	0.23
NMC 66-189,	Newfoundland, Avalon Peninsula, St. Mary's Bay 47°04′ N, 53°34′ W	M	24–58	36	31–34	32.28	0.12
NMC 59-297,	Nova Scotia, south-west Cape Breton Park 46°40′ N, 60°55′ W	F	32–41	16	30–33	31.75	0.22
NMC 71-66,	New Brunswick, Northumberland Co., stream at New Doaktown Bridge 46°33′ N, 66°08′ W	F	32–52	40	31–33	31.80	0.10
NMC 58-317,	Prince Edward Island, Hunter River 46°26′ N, 63°19′ W	F	31–43	22	31–33	32.23	0.11
NMC 64-862,	Québec, Priest Creek near Ottawa 45°44′ N, 75°35′ W	F	26–49	22	32–33	32.36	0.11
NMC 58-324,	Nova Scotia, Oxford 45°44′ N, 63°52′ W	F	21–47	17	29–32	31.41	0.23
NMC 67-177,	Québec, Quyon River 45°43′ N, 76°24′ W	F	31–42	34	31–32	31.41	0.09
NMC 65-335,	New Brunswick, St. John River 45°28′ N, 66°08′ W	F?	33–55	18	31–33	32.10	0.16
NMC 66-215,	New Brunswick, Magaquadavic River 45°07′ N, 66°54′ W	F	38–53	28	30–33	31.64	0.13
NMC 64-688,	Massachusetts, Wellfleet, Cape Cod 41°57′ N, 70°02′ W	M	48–58	5	31–32	31.60	0.24

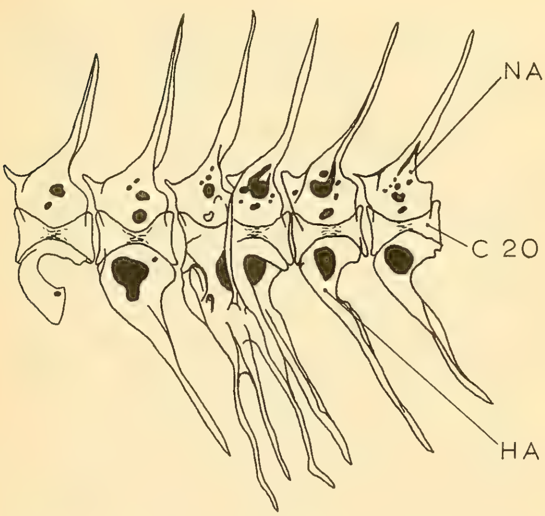

FIGURE 1. Left lateral view of caudal vertebrae of 35-mm standard length *Gasterosteus aculeatus* (NMC 64-862). Note fusion of vertebral centra 17 and 18 and displacement of haemal arches. (C20 = vertebral centrum 20; HA = haemal arch and spine; NA = neural arch and spine).

leback, *Gasterosteus wheatlandi,* from Amory Cove, Quebec was found to contain eight such individuals from a sample size of 56 (Coad and Power 1973a). Both marine and freshwater populations of the fourspine stickleback, *Apeltes quadracus,* may have fused vertebrae (a single individual from each of the samples examined by Coad and Power (1973b)). Palistrophic conditions have not been reported before for these stickleback species.

The degree of fusion in these individuals was not extensive and probably had little effect on their survival ability since many of them were adult fish in their final year of life. The most likely cause of fusion is adverse temperature conditions during ontogeny. Sticklebacks breed in tidal pools or in marginal lake or river vegetation, where marked temperature fluctuations occur during the breeding season (e.g., see Coad and Power, 1973a). The diversity of habitats sampled and the occurrence of this condition in several species would seem to preclude parasitic invasion as a common cause of vertebral fusion. Hereditary factors may play a part but this aspect was not examined.

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Debilitated Condition of Warblers Encountered at Parc Daniel, Gaspé Peninsula

On 12 June 1973, while camping at Parc Daniel, my wife and I encountered two Yellow-bellied Flycatchers (*Empidonax flaviventris*) and eight warblers on the ground and so feeble in the majority of cases that one could catch them readily. The eight warblers consisted of four Bay-breasted (*Dendroica castanea*), and two each of Black-throated Green (*D. virens*) and Magnolia (*D. magnolia*) Warblers. No other species, of either birds or small mammals, of which there were numbers at the park, appeared to be affected. It seemed unlikely, therefore, that a toxic substance such as DDT or Fenitrothion was involved, although this could not be ruled out. A more likely possibility in our minds was that owing to the effects of an unusually cold wet spring, this collection of small fly-catching species was suffering from malnutrition. June 12, unlike the preceding day, was a relatively cold one on which we saw few flying insects of any kind.

It should be noted that none of these birds were injured and none appeared to be ill, the plumages of all of them being in good condition. The first bird I picked up was in the woods 100 m from the camping ground, at 0500 hours. It was a male Bay-breasted Warbler that, when liberated, was able to get up into a low sapling, then to fly feebly to the branch of a balsam. It then moved slowly about in the branches as if looking for prey, staying nearby for some time.

I saw a male Magnolia Warbler on the ground and in a somewhat similar condition an hour later. This was about 2 km from the park. Between these two situations and between 1600 and 1700 hours, we encountered all of the other eight birds along a little-used lumber road. We first stopped the car on encountering a pair of Bay-breasted Warblers. They let me come within 0.3 m and moved away only slowly, as was true of the two flycatchers, one which I picked up, and of the other warblers.

As none of the birds was injured, their presence on the lumber road and in the vicinity of the park seemed to have little to do with these situations and suggested that many others of the same or other species in a similar condition might have been located, if one could have searched the woodlands effectively.

Since writing the above it has been brought to my attention that the debilitated condition might have been a case of birds' just arriving after a long flight, with premigratory energy reserves completely exhausted. Against this is the fact that 12 June was a very late date for such birds to be still migrating, especially in 1973.

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Deformed Vertebral Columns in the Brown Bullhead, *Ictalurus nebulosus* (Lesueur), from the Ottawa River

Abstract. Deformed vertebral columns are reported for some specimens of the brown bullhead, *Ictalurus nebulosus*, from the Ottawa River at Ottawa-Hull. Deformities ranged from a simple vertebral column curvature to major fusions of centra.

Ecological studies on brown bullhead populations in the Ottawa River at Ottawa-Hull have necessitated examination of several thousand specimens. Occasionally individuals were found to have deformed vertebral columns. The vertebral osteology of some of these specimens is described, and data on the occurrence and frequency of the condition are summarized.

Materials and Methods

Bullheads were caught in trap-nets set in shallow water in the Ottawa River. Sample areas near the cities of Ottawa and Hull were (1) Shirley's Bay, (2) Brewery Creek, (3) Governor's Bay, (4) Kettle Island Bay, (5) Upper Duck Island, and (6) Lower Duck Island (see Figure 1).

The standard length (mm), weight (g), and sex of each specimen were determined. Fish were aged by examination of pectoral spine sections (see Scholl 1968). The structure of the vertebral column was investigated by means of radiographs and by alizarin staining (see Hollister 1934). Drawings were made with the aid of a camera lucida.

Results

Most of the deformed specimens were caught in Brewery Creek (Table 1). Other areas in the Ottawa River which were not sampled as extensively as Brewery Creek, however, may contain deformed fish that were not observed. Details of one sample are given in Table 2, where three types of vertebral column deformity are recognised:

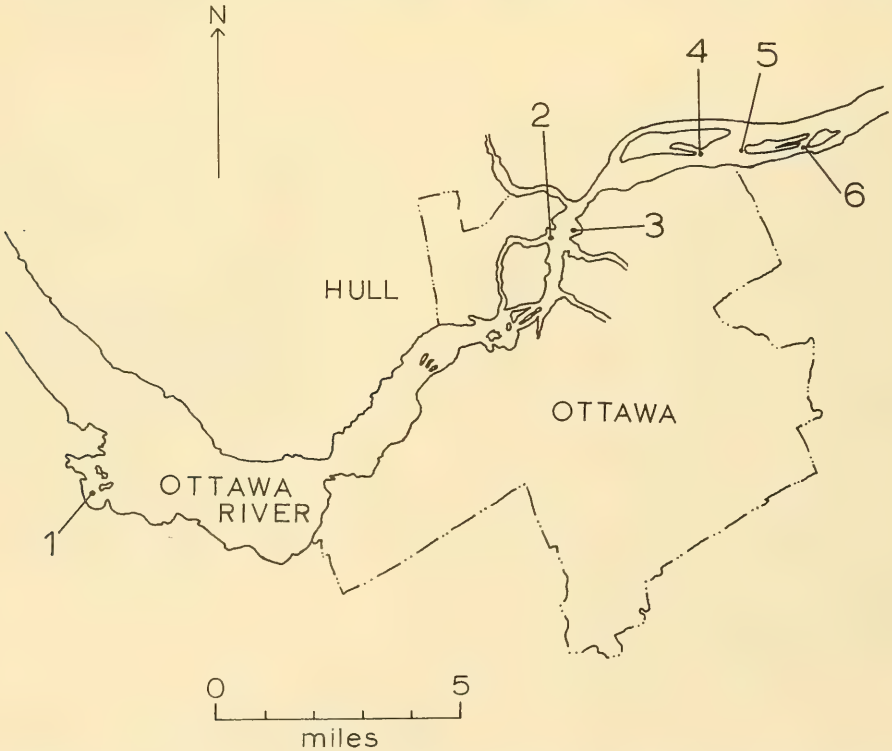

FIGURE 1. Sample areas for brown bullheads in the Ottawa River at Ottawa-Hull: 1, Shirley's Bay; 2, Brewery Creek; 3, Governor's Bay; 4, Kettle Island Bay; 5, Upper Duck Island; 6, Lower Duck Island.

TABLE 1. — Frequency of deformed brown bullheads in samples from the Ottawa River

Capture season	Capture site	Total number caught	Number deformed	Frequency %
Summer 1971	Brewery Creek	5,965	9	0.15
Summer -fall 1972	,, ,,	9,759	22	0.23
,, ,, ,,	Shirley's Bay	4,226	0	0
,, ,, ,,	Governor's Bay	281	0	0
,, ,, ,,	Kettle Island Bay	11,618	0	0
,, ,, ,,	Upper Duck Island	610	0	0
,, ,, ,,	Lower Duck Island	5,905	8	0.14

TABLE 2. — Data on deformed brown bullheads from Brewery Creek, 29 July 1971

Standard length (cm)	Weight (g)	Sex	Age	Type of deformity (see text)		
				(1)	(2)	(3)
13.9	85	♂	5+			*
25.3	224	♀	6+	*		
28.6	346	♂	6+	*		
28.9	274	♂	5+	*		
29.9	339	♂	5+		*	

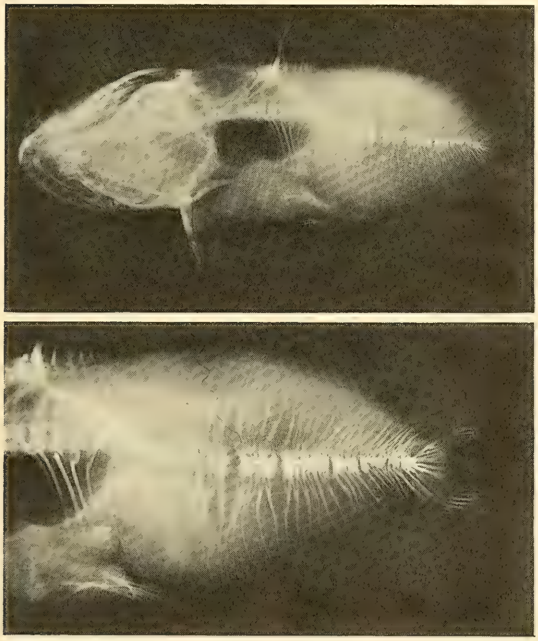

FIGURE 2. Radiographs of a deformed brown bullhead, 13.9 cm standard length, taken from Brewery Creek, 29 July 1971, showing major fusions of caudal centra. Above, whole specimen; below, enlargement of caudal region.

(1) unilateral shortening of centra, causing the vertebral column to assume a gentle S-shape,
(2) a similar condition to (1) but with some fusion of centra,
(3) major fusions of centra, resulting in a markedly shortened body.

The appearance of one individual of type 3, taken in Brewery Creek, is shown in Figure 2. This specimen had a standard length of 139 mm, its weight was 85 g, and it was 5+ years old. Normally 5+-year-old specimens from Brewery Creek are about 265 mm and 233 g during July (based on data for 36 normal specimens). Less complex modifications are shown in Figure 3.

Discussion

The causative factor or factors for these deformities have not been determined. There appears to be no information in the literature on such deformities in brown bullheads (Dawson 1964, 1966, 1971). Various factors have been cited as causing similar deformities during ontogeny in other fish species, including parasite invasion, pollutants, environmental and hereditary factors (Schäperclaus 1954).

The survival of deformed fish depends on several factors. These include the availability of food and the effectiveness of predators. Brown bullheads are principally omnivores and scavengers (Emig 1966) and feed on a wide variety of items that a reduced swimming ability would not impede. Food analyses have shown that walleye and sauger (Priegel 1963) and northern pike (Lagler

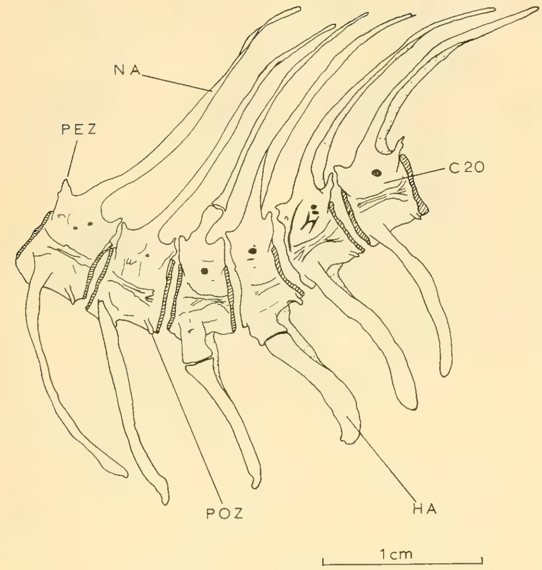

FIGURE 3. Left lateral view of deformed caudal vertebrae of a 29-cm standard length brown bullhead from Brewery Creek, 29 July 1971. C 20, twentieth centrum; HA, haemal arch and spine; NA, neural arch and spine; PEZ, prezygapophysis; POZ, postzygapophysis.

1956) will feed on brown bullheads. Perch may also capture the smaller bullheads (T. A. Clair, personal communication, 1973). Deformities which cause only a slight body curvature will have little effect on the predator escape ability of the bullheads. As their size increases bullheads become less available to predators. They are further protected by their dorsal and pectoral spines (Mauck and Coble 1971). Some indication of the tenacity of life of injured fishes has been given by Gunter and Ward (1961) and is further illustrated herein by the specimen shown in Figure 2.

Acknowledgments

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Gray-headed Junco in Manitoba

On 26 January, 1964, Roy Calder reported to the late Harold Mossop an unfamiliar bird feeding in his St. Vital (Winnipeg) yard. Mossop (1964a) photographed the bird and published the following description: "it's a little less in size than a House Sparrow (*Passer domesticus*). Its plumage is mostly soft grey, a little darker between eyes and bill with much lighter underparts. Outer tail feathers are white and there is a triangle of chestnut-brown on its

back. The bill is very light colored with the tip darker. Its eyes are dark and the plumage of its sides is the same soft, ash-grey." The description clearly fits that of the Gray-headed Junco (*Junco caniceps*) in standard field guides (e.g., Peterson 1961), especially as Mossop later (1964b) specifically considered the possibility of a hybrid between the Slate-colored and Oregon Juncos (then *J. hyemalis* and *J. oreganus* respectively), ruling this out by the "absence of any brown whatsoever on its sides." On 23 February the author and his father, Archie M. McNicholl, accompanied Mossop to the Calder home and observed the bird at distances ranging from about 10 to 40 feet. The chestnut triangle on the back and soft gray sides were carefully checked in detail at close range, and also show clearly on a photo transparency taken by Harold V. Hosford. W. Earl Godfrey (personal communication) has accepted this photo as sufficient evidence to add the Gray-headed Junco to the Canadian list. The junco was observed several times by Mossop and several others until well into March. A possible earlier record for Winnipeg is reported by Dr. Lawrie B. Smith (personal communication), who trapped a junco with a reddish-brown back in a banding trap on or about 28 September 1962. Unfortunately, further details were not noted, as the bird escaped before Dr. Smith was able to examine it more closely.

Although Godfrey (1966) did not have any definite previous Canadian records of this junco, sight records of one each have been reported for March and April, 1971 near Bowman, North Dakota (Stewart 1971; Houston 1971), and there are two recent sight records for Minnesota (Peterson 1969; Carr 1970; Robbins 1970). The usual range of this junco includes California, Nevada, Idaho, Wyoming, New Mexico, Texas, and Mexico (American Ornithologists' Union 1957).

I thank Dr. W. Earl Godfrey for comments on the manuscript, and for examining the photograph; Dr. Lawrie B. Smith for details of his observation; Harold V. Hosford for use of the photograph; and the late Harold Mossop for showing us the bird.

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Abnormal Dentition in Dall Sheep (*Ovis dalli dalli* Nelson)

On August 3, 1973, a Dall ram was shot in the Kusawa Lake area, south-central Yukon Territory, Canada. The ram was seven years and three months old, using the horn-segment count method for aging, as established by Geist (1966) for bighorn sheep and as verified for Dall sheep by Hemming (1969). The animal was normally developed as to body weight, horn growth, and tooth wear. Its skull, however, showed several anomalies of which the most significant was the presence of two supernumerary molariform teeth in the maxillae.

The accepted dental formula for Dall sheep is I (incisors) 0/3, C (canine) 0/1, P (premolars) 3/3, M (molars) 3/3. The canine is incisiform, the premolars are considered to be the second, third, and fourth, while the molars are considered to be the first, second, and third (Hemming 1969; Cowan 1940). The additional teeth are similar in size and shape to P_3. They are located—symmetrically—on the lingual side of the normal tooth-rows of the maxillae, approximately between P_4 and M_1, at a distance of about 7 millimeters, measured at

the occlusal surfaces (Figure 1). The additional tooth of the left maxilla is rotated by about 90 degrees, its buccal cusp pointing anteriorly, and its lingual cusp pointing posteriorly. The additional tooth of the right maxilla is rotated by about 180 degrees, its buccal cusp being on the lingual side, and its lingual cusp on the buccal side. The attrition on each supernumerary tooth is congruent with the wear pattern of the adjacent P_4, suggesting that both pairs had erupted at about the same time. The opposing tooth to the supernumerary tooth and the adjacent P_4 is the mandibular M_1. The even wear necessitated considerable lateral movement of the lower jaw during mastication.

The skull of this ram shows the following additional anomalies: the frontal bones are incompletely joined between the horn bases, leaving an opening to the cranial cavity of about 20 millimeters by 5 millimeters in size. The nasal bones are absent. Both mandibular P_2's are absent, and the third (posterior) lobe of both mandibular M_3's are only rudimentarily developed.

Except for Murie (1944), who discusses malformed teeth in relation to actinomycosis, I am not aware of any published information with regard to dental anomalies in Dall sheep. Considerable information, however, is available for Desert Bighorn sheep (Bradley and Allred 1966; Allred and Bradley 1965) and for members of the deer family. The most recent publications are those by Miller and Tessier (1971) for caribou, Mech et al. (1970) for white-tailed deer, and Pekelharing (1968) for red deer and wapiti.

Over the past five years the writer had the opportunity to inspect over 400 Dall sheep skulls. So far all anomalies consisted of the absence of teeth or of malformations. This is the first specimen in which supernumerary teeth were encountered.

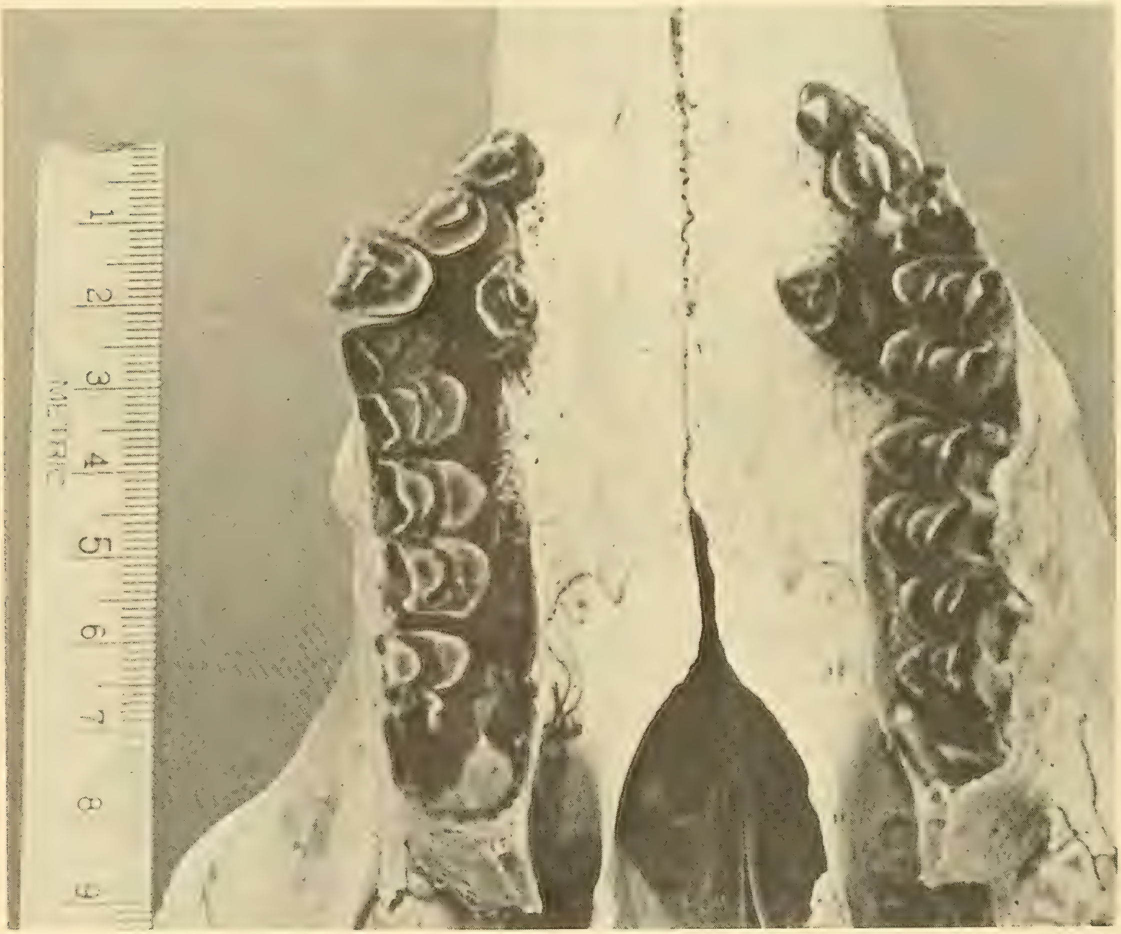

FIGURE 1. Occlusal view of maxillary tooth rows showing supernumerary molariform teeth.

The skull is deposited in the collection of the Yukon Game Branch at Whitehorse.

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Loiseleuria procumbens (L.) Desv., Alpine Azalea, in Alberta

There has been considerable confusion in the reports of the presence of *Loiseleuria procumbens* (Ericaceae) in Alberta. Moss (1959) did not include the species in his *Flora of Alberta*. Campbell (1900), however, reported *Loiseleuria procumbens (sub Chamaecistus procumbens* (L.) Kuntz) from Tunnel Mountain, Banff. Boivin (1967b) discounted this and referred to a comment in his later publication under *Coronopus didymus* (Boivin 1969): "Most later authors have ignored the many papers by Campbell and his numerous additions and range extensions. And rightly so as nearly all his unusual reports and many of the run of the mill ones are based on errors of identification. Thus his reports of *Silene acaulis* and *Sibbaldia procumbens* from Wolseley, Sask. are based respectively on *Phlox hoodii* (QK; DAO, photo) and *Potentilla concinna* (QK; DAO, photo). Other reports by Campbell were systematically ignored; too many of them border on the fantastic." Actually, two collections, made by Campbell and misidentified by him as *Loiseleuria procumbens* exist. These are labelled vaguely as "Above Lake Louise, Laggan, Rocky Mts., June 1897" and "Banff, B.C., June 1897" (MTMG). They were revised to *Vaccinium vitis-idaea* var. *minus* and *Empetrum nigrum* var. *purpureum* respectively, by Bernard Boivin in 1970.

Hultén (1948) included "Alberta (54°N)" in his description of the geographical areas in which *Loiseleuria procumbens* is found. The report in Boivin (1966 and 1967), and possibly also that of Fernald (1950), is based on the information given by Hultén (1948). Boivin (1967b), however, believes that Hultén's report is likely based on a misreading of Hooker (1834, *sub Azalea procumbens* L.), which was repeated by Macoun (1884), "Mount Edgecombe, lat 54°." This mountain, as pointed out by Boivin, is in the Alaska Panhandle in the vicinity of 54°, not in the Rockies of Alberta.

Hultén (1958) in his *Amphi-Atlantic Plants* apparently ignored his earlier information, because he does not show any records from Alberta on his map. In his *Flora of Alaska and Neighboring Territories* (Hultén 1968) however, there is a circle on the circumpolar map which might be interpreted to cover a portion of the Rocky Mountains of Alberta.

Recent collections of *Loiseleuria procumbens* from Jasper National Park are thus of considerable interest. Data are as follows: Tonquin Valley, *N. B. Sanson* (undated) (ALTA); same locality, *J. G. Packer*, Aug. 15, 1958 (ALTA) (Packer and Dumais 1972); same locality, alpine communities of the slopes of Mount Clitheroe, 52°43′30″ N, 118°15′ W, altitude 7500 ft, *G. W. Scotter 17104* (DAO). On the latter specimen, immature capsules were dark purple in color when the plant was collected on 17 July 1971.

Dr. Erling Porsild, in conversation with the senior author, revealed that he too had collected *Loiseleuria procumbens* in Jasper National Park. This was in 1958

when he was preparing for the botanical field trip which he led to Banff and Jasper Parks in 1959 as a part of the IX International Botanical Congress. His specimen was collected on a fresh moraine west of the Chalet on Mt. Edith Cavell (CAN). He saw only one patch at that time. The specimen would not have been available to Eric Hultén when he was preparing his *Flora,* published in 1968. It is quite possible that he either collected or saw *Loiseleuria* in this vicinity because he was one of the participants in the 1959 field trip and would have been well aware of its distributional interest, or that he saw the Packer collection.

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An Incubation Period and a Nestling Period for the Fox Sparrow

Terrill (1968) reports that little is known about the incubation period of the eastern Fox Sparrow, *Passerella iliaca iliaca.* Also, no record can be found of a nestling period. Estimated reports of the incubation period have been given as follows: Forbush (1929) says it is "probably 12 to 14 days" and O. L. Austin, Jr. (1932) thinks it is "about 13 days." There is equally little known about the incubation period of the western subspecies. Gabrielson and Lincoln (1959), speaking of the subspecies *P. i. zaboria*, state that "the period of incubation is the 12 to 14 days that is common among sparrows of this type and the young usually remain in the nest a somewhat shorter period." For another subspecies, *P. i. schistacea*, Bendire (1889) stated that "Incubation, as nearly as I was able to determine, lasts from twelve to fourteen days."

The following account describes two nests of Fox Sparrows near Bonavista, Newfoundland, during 1971 and 1972. Particular reference is given to an incubation period and a nestling period for the 1972 nest.

The spring of 1972 was late and cold, the last significant snowfall being on May 13. Snow and ice, however, remained in sheltered areas until about May 23. Despite the unfavorable weather, Fox Sparrows had set up territories by May 3. A nest was found on May 20, consisting of a well-formed cup sitting against the trunk of a balsam fir, *Abies balsamea*, about 6 feet above ground. Its outer rim consisted of dry balsam fir and spruce (*Picea* sp.) twigs, the lining being fine grasses, rootlets, a small amount of sheep's wool, and a few feathers. The major part of the nest, however, was dry scaly bark and dead shredded wood of balsam fir mixed with broom moss, *Dicranum* sp.

The first egg was laid between the evening of May 22 and the morning of May 23. By the morning of May 25, the third and final egg had been laid and an adult was observed sitting on the nest. There was no evidence of incubation before the third egg was laid. At 10 A.M. on June 7 the eggs showed no signs of hatching; however, at

6:30 P.M. two of the eggs were hatched and the third was pipped. The next morning there were three chicks present. Using Heinroth's definition, translated in Thompson (1964), that the incubation period is "the time from laying of the last egg of a clutch to the hatching of that egg," then the incubation period of the above eggs was 14 days.

Skutch (1945) has defined nestling period as "the interval between the hatching of the young bird and its departure from the nest." The young were still in the nest on June 17 but had left by the morning of June 18. Assuming that they left early June 18, this gives a nestling period of about $10^{1}/_{2}$ days. The total time from laying of the first egg to the young leaving the nest was 26 days.

The Fox Sparrow often nests early in Newfoundland. During the spring of 1971, territories were proclaimed by April 22. On May 1, a bird was seen carrying dry grass in its beak, presumably for nest building. A second bird, probably its mate, was chipping nearby. A nest was discovered on May 16 with a clutch of three eggs. On May 23, two young about a day old were found in the nest.

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Erythristic Red-backed Salamanders, *Plethodon cinereus,* from Ontario

Previously the erythristic, or all-red , morph of the Red-backed Salamander (Barbour 1914) was known in Ontario by three specimens from Wentworth County, 7 miles east of Hamilton at Albion Falls (Brown 1928). An individual from the Toronto area was vaguely described as showing an abnormal degree of red (Piersol 1909), and has been cited by Thurow (1961) as a questionable record of this morph. It is also possible that this salamander displayed red-legs characters (Schueler 1974): red around the sides of the neck, on the forelegs, and in extreme cases visible on the venter.

On April 18, 1971, P. A. Westell and Keith Maykowski collected seven *Plethodon cinereus* in Halton County, about 2 miles southeast of Campbellville on the Niagara Escarpment. Most of these were found in leaf litter under rotten logs; however, the erythristic individual and another adult were under broken concrete in an open field close to the edge of the scarp.

Another erythristic specimen was collected by F. D. Ross April 23, 1971, at Highland Point, about 1 mile northwest of Penetangueshene, Simcoe County. Although snowcover was extensive and often of considerable depth, this individual was taken from beneath a shallow rock on an exposed slope. It was the only salamander seen there.

In the Elora Gorge, south from Elora on the Grand River in Wellington County, another erythristic *P. cinereus* was taken by P. A. Westell on August 1, 1973. With the assistance of a group of boys from the Guelph YMCA daycamp, 28 other Red-backed Salamanders were taken then, and an additional 76 on August 2, all of which were under limestone rocks. Many of these had red-legs characteristics.

The Campbellville specimen was red on the dorsal and lateral surfaces of the head, trunk, and tail. The lateral surfaces of the trunk, however, were flecked lightly with black. The tail had been broken some time before capture, and the entire regenerated portion was black.

The Highland Point specimen showed more black pigmentation. The head was red and slightly grayish above. The dorsal surfaces of the trunk and tail were entirely red. The lateral surfaces of the trunk were flecked with black, coalescing into a pair of dorso-lateral stripes posteriorly. A band just behind the legs was the only invasion of red on the lateral surfaces of the tail.

The specimen from the Elora Gorge was red on the head and the dorsal surface of the trunk. Flecking on the lateral surfaces of the trunk was heaviest posteriorly and dorsally, but not nearly so dense as to form dorso-lateral stripes, as with the previous specimen. The tail was al-

most entirely black, with only vestiges of the dorsal stripe remaining red.

Elsewhere this morph has been recorded in Quebec (Rosen 1971), New Brunswick, Nova Scotia (summarized by Gilhen (1968)), Ohio (Pfingsten 1969), New York, Connecticut, Massachustees, and New Hampshire (summarized by Thurow (1961)).

The Campbellville collection has been deposited in the Herpetology unit of the National Museums of Canada (NMC 12968), as has the collection from the Elora Gorge (presently uncatalogued). The single specimen from Highland Point has been lost; copies of the slides on which the description was based (Kodachrome, FDR) have been filed in the NMC.

We thank Messrs. F. W. Schueler and F. R. Cook for reading the manuscript, and the Guelph YMCA daycamp program for providing the manpower and opportunity to capture the large sample from Elora Gorge.

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The Indigo Bunting in British Columbia

The Indigo Bunting (*Passerina cyanea*) breeds from the Gulf Coast of the United States north to southern Manitoba and Maine, and winters from central Mexico to Panama and the West Indies (Godfrey 1966). Its status in British Columbia is listed as hypothetical (Godfrey 1966), based on a single sight record by Mr. Sam H. Hopkins, near Trail in the summer of 1958 (Godfrey 1973, personal communication).

Also in the West Kootenays, Street and Merilees (1974) reported a sight record of a male Indigo Bunting at South Slocan between June 30 and July 26, 1972.

But there have been at least five other convincing sightings of Indigo Buntings in British Columbia, two of which are documented with photographs.

On June 23, 1968, Mr. Roy Phillips of Vancouver saw a male singing on the Seabird Island Indian Reservation, 6 miles east of Agassiz. He returned a week later and saw what was probably the same bird, although it had apparently begun to molt, showing patches of light feathers on its breast. Gwen de Camp and Jack and Eileen Husted also saw the bird on this visit, and a written description by Gwen de Camp is on file at the British Columbia Provincial Museum.

On June 2, 1973, another male was seen and photographed at the feeder of Mrs. Marion Linn in Lion's Bay, West Vancouver. The bird was first seen on June 1, and Mrs. Ed MacDonald and Mrs. Virginia Whitelaw also saw it on June 3. The photograph is No. 312 in the Provincial Museum Photoduplicate file (PDF) (see Campbell and Stirling 1971).

A male was sighted later that month, on June 20, two miles south of Spence's Bridge, by David Evans. A written description of this sighting is at the British Columbia Provincial Museum.

The latest record was of a male seen by George P. Sirk, Lauren Sirk, and myself near Magna Bay, Shuswap Lake

on July 7, 1973. I first heard the bird singing, and assumed it to be a Lazuli Bunting, which has a similar song and is common in that area. We checked it with 7× binoculars, however, and immediately noticed its total dark blue color. George Sirk took three color transparencies using a 400-mm lens, two of which are on file at the British Columbia Provincial Museum (PDF No. 313). The bird's behavior suggested that it was breeding and had a territory, but it was gone when we checked the area the next morning and on subsequent days throughout July.

The Indigo Bunting has been added to the official list of the birds of British Columbia (Campbell, personal communication), and in light of the latest records, should be considered as a casual summer visitor to the province.

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A Possible Yellow-shafted Flicker Nest in a River Bank

In a general statement Bendire (1895) and Burns (1900) report that in the prairie states the Yellow-shafted Flicker (*Colaptes auratus*) occasionally selects burrows of Belted Kingfishers (*Megaceryle alcyon*) and Bank Swallows (*Riparia riparia*) for its nest site. Specifically, Bradshaw (1930) and Porter (1932) report on Yellow-shafted Flicker nests in the banks of the Frenchman River in southern Saskatchewan. Red-shafted Flickers (*Colaptes cafer*) nesting in river banks are reported from Arizona and New Mexico (Henshaw 1875), the Ogden and Weber Rivers in Utah (Allen 1872), Willow Creek in Oregon (Peck 1911), California (Dawson 1923), and Colorado (Bailey and Niedrach 1965). I have not found any records for the Gilded Flicker (*Colaptes chrysoides*).

In South America three species of *Colaptes* have been found to nest in river banks and similar places. In Peru, Dorst (1956) and Short (1971) find that the Andean Flicker (*Colaptes rupicola*) is completely terrestrial and nests primarily in river banks in small colonies. The Chilean Flicker (*Colaptes pitius*) nests in road cuts, steep mountain slopes, and holes in river banks (Johnson 1967) in some areas but in trees in other areas. Darwin (1870) mentions the terrestrial habits of the Campo Flicker (*Colaptes campestris*) on the Pampas. Azara (1802–1805) states that this species digs its nest in river banks, but Hudson (1920) points out that it also nests in trees. Some South American Flickers, then, dig their own burrows in river banks. In North America only Henshaw (1875) states that the Red-shafted Flicker digs its own nest in river banks.

On June 28, 1972, at about 14:00, we paddled in a canoe down the Abitibi River in northern Ontario. We were approximately 4 km north of where the Onakawana River comes into the Abitibi. At this point the Abitibi has some steep cliffs. I had been watching similar cliffs on preceding days for the presence of Belted Kingfisher nests. Almost all such cliffs were occupied by the kingfishers. At this particular point no kingfishers were present, but the cliff did show an old nest entrance (presumably dug by kingfishers) approximately 1 m from the top of the cliff and 5 m above the river. To my surprise a Yellow-shafted Flicker emerged from the earth tunnel and flew, agitated, to the top of a nearby dead tree from where it watched us. As there was no way to get to the nest we proceeded to drift down the river. When we were about 150 m away I saw a flicker entering the burrow.

At this particular point along the river some large trees (*Populus tremuloides*) stand among the more spindly spruce (*Picea mariana*) that characterize the muskeg. The flickers could have chosen one of the larger poplars for a nest site. Along the river edge, however, these trees tend to be rather dense, and as flickers prefer more open habitat they may have chosen the burrow in the cliff to fulfill this condition. I may add that we frequently flushed flickers from the river edge, especially along the narrower Onakawana, where the birds fed on the ground in the low vegetation.

The ability to nest in earth tunnels allows flickers to invade areas largely devoid of trees, not only in the prairies and the arid regions of the Southwest but perhaps

also in the north of the continent where trees in general are too small and thin to allow for excavation of a nest. Significantly, the Yellow-shafted Flicker, despite its large size, reaches farther north than any other North American woodpecker (see Godfrey 1966), except possibly the Northern Three-toed Woodpecker (*Picoides tridactylus*). We know little about its nesting habits in those regions.

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Another Record of the Flammulated Owl in Canada

The Flammulated Owl, *Otus flammeolus* (Kaup), breeds from the highlands of Guatemala north through the western mountains to southern British Columbia (Godfrey 1966). In British Columbia it is an extremely rare and local breeder. The only recorded nest in the province was found on June 12, 1962 at an elevation of 4000 feet, 20 miles west of Penticton. A female owl and eggshells were discovered after a ponderosa pine was felled by a logger. The nest hole was 40 to 50 feet high in the trunk (Atkinson 1963).

Other specimen records include a bird found dead on the shore of Okanagan Lake at Penticton, November 1902 (Brooks 1909) and one collected August 11, 1935 at Lac du Bois, 12 miles northwest of Kamloops (Williams and Spencer 1942).

The fourth record of the Flammulated Owl turned up recently while I was examining some bird records in my father's files. Photographic negatives taken on August 23, 1947 at Trout Creek Point, Summerland, British Columbia, by S. R. Cannings, show a young owl perched on a branch and in the hand. Except for down remaining on the head and breast, the bird is completely fledged. Its length is estimated at 6 inches. The dark eyes and naked toes are obvious.

Notes taken at the time indicate the owl was sick and would not eat. It died the next day. Unfortunately, the importance of the bird was not recognized at the time and the specimen was not preserved. The combination of small size and dark eyes, however, convinced me the photographed bird was a Flammulated Owl, and subsequent correspondence with the National Museum, Ottawa, confirmed the identification (Godfrey, personal communication).

Prints of the photographs are on file at both the British Columbia Provincial Museum (Photoduplicate File No. 317) (Campbell and Stirling 1971) and the National Museum of Canada.

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Brown Thrasher on the Coast of British Columbia

The Brown Thrasher (*Toxostoma rufum*) ranges from southern Canada east of the Rocky Mountains to the Gulf States (A.O.U. 1957). In Canada it is a summer resident, breeding from southeastern Alberta, eastward across southern Canada to the Maritime provinces (Godfrey 1966). In British Columbia this Mimid was first recorded at Penticton where a bird was photographed in the fall of 1970 (Cannings 1972). Since that time there have been two coastal records of vagrants which are noteworthy.

On February 23, 1973, Dr. and Mrs. H. Tarr, 5996 Eagle Harbour Road, West Vancouver, identified what they thought to be a Brown Thrasher at their feeding station. Later, after realizing the significance of their observation, they notified J. Rodgers, columnist with *The Vancouver Sun* newspaper, who in turn contacted me. On the morning of March 10, W. C. Weber and I visited the Tarr's residence and waited for the thrasher to appear. Just before noon it emerged from a fencerow of blackberry brambles and flew to the feeder. Field notes were taken and nine 35-mm color slides were obtained to document the occurrence. Local naturalists were notified and during the next few weeks at least 43 people had seen the thrasher.

On March 10, black-and-white photographs were secured by newspaper photographer Deni Eagland, one of which appeared in *The Vancouver Sun* the following day. A different photograph has also appeared in the publication *American Birds* (Volume 26(3): 647; 1972). R. W. Phillips obtained more color slides on April 1, several of which show the adjacent surroundings, the feeding station, and Song and Fox Sparrows for size and color comparisons. Copies of all these photographs have been accessioned as PDF 200 in the photoduplicate file of British Columbia vertebrate records (see Campbell and Stirling 1971) in the British Columbia Provincial Museum in Victoria.

The Brown Thrasher visited the feeding station almost daily (for 66 days) and was last seen by Mrs. Tarr on April 29.

I am aware of one more record for British Columbia, that of a single bird seen by Adrian Dorst at the Comber's Resort, Long Beach, on the central west coast of Vancouver Island, on November 17, 1973. The bird was not photographed but highlights of his field notes, a copy of which are on file in the Provincial Museum, are as follows: "length as about that of a jay but more slender . . . rufous above, pale below with dark streaks on breast. I distinctly noted its slightly decurved bill and two light wingbars. The tail was long in relation to its body." The thrasher was seen by Dorst's wife later that day and then on several occasions on November 21.

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Melting of Snow and Ice in the Mer Bleue Sphagnum Bog near Ottawa, Canada[1,2]

The Mer Bleue, 10 miles east of Ottawa, Canada, is a 5000-acre sphagnum bog about 2 by 4 miles in size and irregular in shape (Figure 1), and is of particular interest and value for ecological studies because all stages of plant succession are represented. The area is dominated by leatherleaf (*Chamaedaphne calyculata*) and by stands of variously aged black spruce (*Picea mariana*). It has been burned by numerous fires at different locations since the 1920s and a ditch dug in 1928 has permitted invasion by aspen (*Populus tremuloides*) and gray birch (*Betula populifolia*) on hydromorphic soil, the latter forming a park-like stand (Joyal 1970, 1972). This raised bog, tending for the most part toward ombrotrophy, is probably the farthest inland of any in southeast Canada. Snow and ice depth records were obtained during two winters, affording data on interesting and ecologically significant variations between communities.

The climate of the region, based on Thornthwaite's (1948) classification, is of the humid, mesothermic type ($B_3B_1^1$). The average annual temperature is 42°F, with an average of 60°F in July and of 13°F in January. Average annual precipitation is 25 inches of rain and 85 inches of snow, for an equivalent of 33.5 inches of water. In general, the snowfalls are abundant enough to cover completely the ericaceous associations. In the 50-year-old black-spruce stand the branches trap a part of the freshly fallen snow so that the tips of the shoots of leatherleaf and of bog laurel (*Ledum groenlandicum*), for example, are usually bare.

Methods

Snow depth was measured at five different locations, of which three are in the heath formation and two in a 50-year-old black-spruce stand; standard wooden snow gauges were used, 2 by 2 inches by 8 feet long. Data were collected at least once a week and on the day after each snowfall. Observations were continued until the snow had completely disappeared from all five sites.

Ice thickness in the sphagnum bog was measured weekly by using an ice-borer at the same two sites, under natural conditions—that is, where the snow cover had not been disturbed by man. In the spring the speed of melt was calculated twice a week in 10 hummocks and 10 hollows chosen randomly in the bog-laurel association.

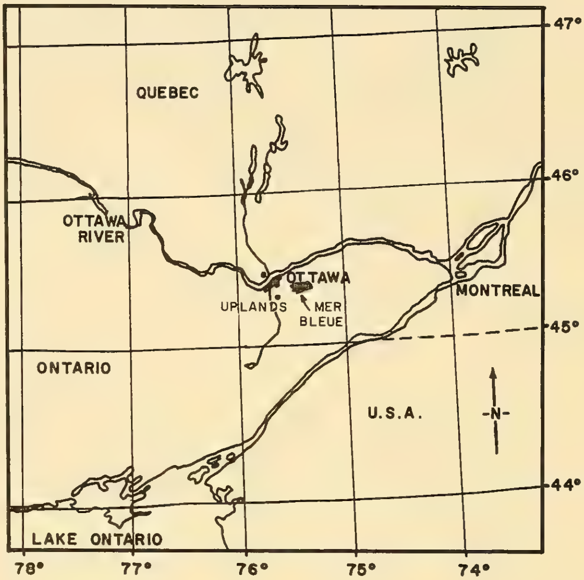

FIGURE 1. Location of the Mer Bleue sphagnum bog.

Results

The total snowfall in the Ottawa region was 93 inches in 1965–1966 and 98 inches in 1966–1967, and the average maximum thickness in the Mer Bleue was, respectively, 36 and 37 inches in the bog-laurel community and 21 and 20 inches in the 50-year-old black-spruce stand (Figure 2). At Uplands Airport, 7 miles west, maximum thickness was 22 and 27 inches for these two winter seasons.

The snow cover in the black-spruce stand, although thinner, melts more slowly in the spring and the soil is not clear until May. In the ericaceous communities the snow is generally gone by the beginning of April. The maximum thickness usually occurs at the end of February or the beginning of March, depending on the date of the last annual snowstorm. The snow melt begins first in the aspen and birch stands because the better-drained oligomorphic soil warms up more rapidly, whereas the black-spruce stand holds the snow later in the spring because of the presence of the conifer layer. The greater thickness of the ice layer in wooded areas is certainly due to the thinner snowcover, which offers less insulating protection.

[1]Contribution No. 6 to the series "Scientific and Cultural Studies of the Mer Bleue" (see The Canadian Field-Naturalist 83(1): 4–6, 1969).

[2]Part of a Ph.D. thesis submitted to the Department of Biology, University of Ottawa, Canada.

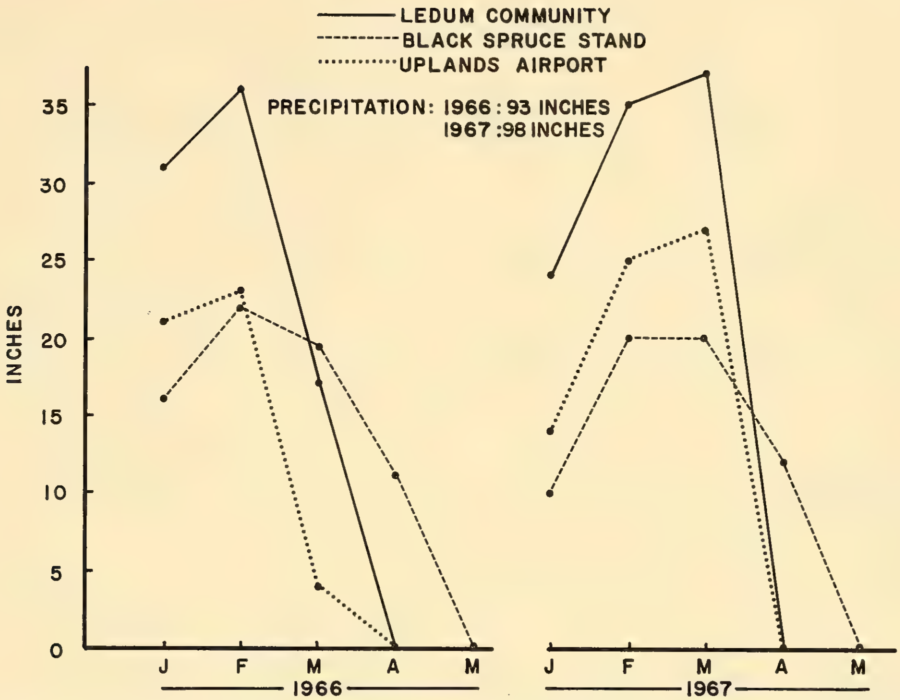

FIGURE 2. Snow depth in 1966 and 1967 (January to May) at two sites in the Mer Bleue and at Uplands Airport.

After snowmelt is the time of year when walking on the Mer Bleue is facilitated because of the disappearance of the obstructing snow layer. Open water is far below the surface and the thick ice layer easily supports a man. Because the mineral soils of the region surrounding Uplands Airport are better drained and exposed to the sun, they are completely thawed by the beginning of April; in the Mer Bleue a thick layer of ice persists at the surface in all sectors. Naturalists, miners, foresters, etc., can profit from this short period to traverse broad expanses of sphagnum bog before the water table rises to the surface.

TABLE 1 —Depth (D) and thickness (T) (in inches) of ice in hollows in the principal plant associations during 1966

Associations		March 29	April 5	April 12	April 19	April 25	May 2	May 9	May 17	May 24
Ledetum	D	1.5	2	4	4	6	—	—	—	—
(bog-laurel)	T	8	7	5	3	1	—	1	—	—
Chamaedaphnetum	D	2	2	5	5	6	—	—	—	—
(leatherleaf)	T	8	7	4	4	2	—	1	—	—
Piceetum ericaceum	D	0	0	2	3	4	5	5	5	—
(25-year-old black spruce)	T	10	10	8	6	5	3	2	1	—
Piceetum marianae	D	0	0	0	2	4	5	4	5	7
(50-year-old black spruce)	T	12	12	12	10	6	5	5	4	2
Populetum	D	0	9	6	6	6	—	—	—	—
(12-year-old poplar stand)	T	10	1	3	3	1	—	—	—	—

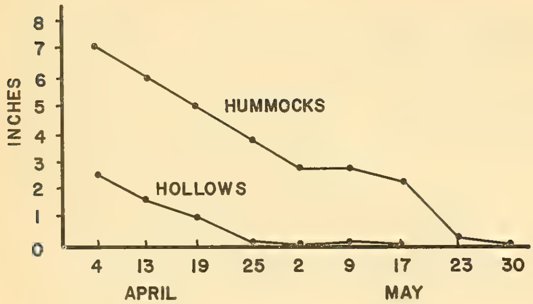

FIGURE 3. Difference in thickness of ice in the hummocks and hollows in the *Ledum* association during the winter of 1966.

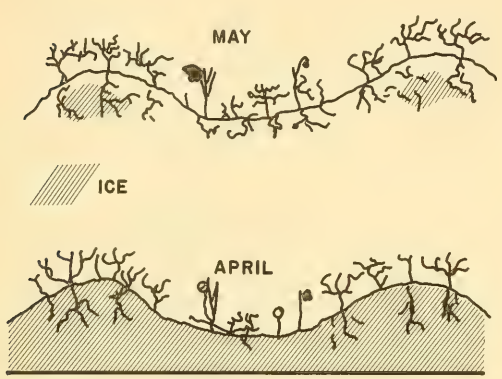

FIGURE 4. Profile of the peat in spring, comparing the thickness of ice in April with the pockets remaining in the hummocks in May.

The ice thickness in the sphagnum peat varies according to the plant communities. Table 1 presents the average depth and thickness of ice at stations in the *hollows* within each of the communities. These measurements show that sometimes the depth at which we find ice has not increased from one week to another, even though the thickness of the ice itself is less. This leads us to conclude that the ice must melt from underneath, thus confirming Stoeckeler's (1965) findings.

After a period of ice melt, walking becomes easier on hummocks than in hollows where the melt is faster. Figures 3 and 4 illustrate the difference in speed of melt according to microrelief. The thickness of ice is much more important in the hummocks where it disappears very slowly; ice can still be found there almost a month later than in the hollows. The snow layer covering the hummocks is necessarily thinner than in hollows, thus favoring a greater accumulation of ice in the former.

At the beginning of June 1966, the sphagnum peat in the black-spruce stand still held 2 to 6 inches of ice at several places in shaded hummocks. The 1967 melt occurred identically to that of 1966: the bog-laurel community and the aspen stand were freed first, whereas the black-spruce forest held ice pockets much longer. The phenomena were finished two weeks earlier, however, the spruce area containing 1- to 4-inch-thick plates of ice only until May 15. Similar studies in Wisconsin (Stoeckeler 1965) and in Minnesota (Heinselman 1963) produced comparable findings.

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Notes on the Prehistoric Distribution of Longnose Gar, *Lepisosteus osseus*, in Lake Erie

Recent archaeological investigations in southwestern Ontario indicate the presence of *Lepisosteus osseus* or longnose gar in Lake Erie by the 7th century or 8th century A.D.

D. E. McAllister (1962. Fish remains from Ontario Indian sites 700 to 2500 years old. National Museums of Canada Natural History Papers, Number 17. pp. 1–6) identified fish remains collected from three prehistoric archaeological sites in southwestern Ontario and suggested that owing to an absence of longnose gar remains in older sites, the occurrence of this species in the St. Lawrence River was a relatively recent phenomenon. An approximate date of 1200 A.D. to 1300 A.D. was indicated for the initial penetration of the longnose gar into the St. Lawrence and the Great Lakes (McAllister 1962, p. 6).

The excavation of a terminal Woodland site at Point Pelee on Lake Erie has produced 12 skeletal remains of *Lepisosteus osseus*. These remains include a part of a dentary bone and several of the characteristic gar scales. Four radiocarbon determinations on this prehistoric occupation at 1320±95, 1146±57, 1110±95, and 1072±55 radiocarbon years, in close association with the fish remains, place the age of this sample at approximately 800 A.D.

The absence of longnose gar among the fish remains from the Goessens and Stafford sites, which are also located on Lake Erie, as reported by McAllister, may reflect incompleteness of the archaeological sample, absence from the local but not the regional fauna, or selective aboriginal exploitive patterns. Presence of remains of this species at the earlier Point Pelee site indicates that longnose gar were in Lake Erie at least as early as 800 A.D.

The authors thank D. E. McAllister and J. V. Wright for their helpful comments.

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Book Reviews

Zoology

Freshwater Fishes of Canada

By W. B. Scott and E. J. Crossman. 1973. Fisheries Research Board of Canada Bulletin 184. Information Canada, Ottawa K1A 0S9. xiv + 966 pp., numerous illustrations and maps, six color plates. $9.75.

This is without a doubt the finest book to appear on the freshwater fishes of Canada or, for that matter, on any national freshwater fish fauna on the continent. Its nearly 1000 pages are richly illustrated with figures and maps, and a wealth of information is provided on the 181 species (including four introduced) known to occur in Canada at the time of writing.

The introduction is brief. Species lists are provided for each province as well as for each of the five major drainage basins found in Canada. In place of a history of ichthyology in Canada (a topic well covered by Dymond, Copeia, 1964), a list of important publications on the Canadian freshwater fish fauna is provided. Instructions for preserving fish specimens are followed by an outline of the species account, which typically includes the following: Description, Color, Systematic notes, Distribution, Biology, Relation to man, Nomenclature, and, at the end of each family group, Suggested reading, Sketches of anatomical features and a key to the families end the introductory section.

Each order and family represented in Canada is briefly described; the latter is often embellished with a world distribution map. Keys to species which precede each family (with more than one species) are quite workable, having been tested and used by students and biologists for several years. Occasionally, however, the user will have to make unnecessarily long lateral line scale counts where a shorter count above the lateral line would have been quite satisfactory. Usually, several characters are used in each couplet and excellent drawings illustrate many of the more abstruse characters (note that drawings on pp. 142 and 167 are inverted).

The species accounts have boldface subheadings which quickly identify various sections. A brief "Diagnosis" preceding the description would have enabled the reader to verify identifications quickly. Many of the descriptions are based on new data obtained from Canadian specimens, and some descriptions detail geographic variation. Unfortunately, body proportions of specimens are expressed primarily in terms of total length rather than standard length. This will make it difficult to compare proportions from this manual with those obtained by other workers and, furthermore, may lead students to use the inappropriate length measurement. The rationale of the authors is that there are several methods of measuring standard length; but they fail to mention that the same applies to total length, and which "total length" they use is not stated. Comparable manuals on other segments of the Canadian ichthyofauna (*Pacific Fishes of Canada, Freshwater Fishes of Northwestern Canada and Alaska*) express proportions in terms of standard length.

The nomenclature employed tands to be conservative, and recent nomenclatural changes, even when well documented, are accepted with caution. Subspecies are not treated separately (except for *Esox*!) but are discussed under systematic notes. A brief "summary" of nomenclatural changes, and etymology, and list of common names is found at the end of each species account.

One of the most valuable sections in each account is the summary of life history information appearing under "Biology." An excellent account of reproduction, habitat, food, predation, and parasites is abstracted from literature pertinent to Canadian populations or from their own data. Numerous instances are indicated where additional work is required; hopefully biologists will take up the challenge.

Line drawings and, in a few cases, color paintings or photos illustrate roughly 175 of the 181 species. Most of the drawings are of high quality. A few, such as those of the banded killifish and pugnose shiner, are mediocre. The rainbow smelt is incorrectly depicted as possessing a complete lateral line. Uniformity is marred by ³⁄₄-views, some species being shown from the right side, some from the left, and in varying degrees of reduction; some drawings occupy less than one-half of the page width while others occupy the full width.

The spot distribution maps are an invaluable feature of this text. In many cases these are the first maps of the species' range in Canada. Shading indicates the total Canadian range, but those portions of ranges resulting from introductions are usually not distinguished from the native distribution. Omission of such records as ninespine stickleback on Banks Island, cisco and round whitefish at Povungnituk, and various redhorses in the Ottawa region, to mention a few, could have been avoided if the authors had consulted the collections of the National Museum of Natural Sciences. Insets of world range maps in the Canadian range maps are a worthwhile feature, although they are not all correct (e.g., Lepisosteidae, Hiodontidae, "Salmonids" (= Salmonidae?)).

In the Glossary, not all definitions are precise (e.g., that for "teleost" applies to "teleostome") although they are adequate. The number of references cited (more than

1400) is impressive and indicates the thoroughness of literature review.

The authors footnote that three species new to the Canadian freshwater ichthyofauna were found after the manuscript was completed. A fourth, *Noturus insignis*, has subsequently been found.

Freshwater Fishes of Canada is a landmark publication in ichthyology. It is masterfully written and well illustrated. We wholeheartedly recommend its use by anglers, naturalists, and biologists. At $9.75, it is undoubtedly one of the biological book bargains of the year.

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The Snakes of Canada

By Barbara Froom. 1972. McClelland and Stewart Limited, Toronto and Montreal. 128 pp. 21 colored illustrations. $6.95.

Barbara Froom is a relentless propagandist for a more enlightened public attitude toward the Canadian herpetofauna. She has served as editor for, and editorialized in, the Canadian Amphibian and Reptile Conservation Society Bulletin since the society's inception in 1961. Among her past published contributions have been popular booklets on the snakes and the turtles of Ontario, issued by the Ontario Department of Lands and Forests (now the Ministry of Natural Resources), and on the Massasauga in Ontario, distributed by the Federation of Ontario Naturalists. She has been ever available to the local press and television whenever they provided an opportunity to debunk the myths and fears that cloud the public image of these needlessly maligned animals.

The present undertaking, a book which encompasses all Canadian snakes, is her most ambitious project to date. No previous Canadian publication treats the appearance and natural history of all our species of even one group of Canadian amphibians and reptiles, though guides to most provincial herpetofaunas and a comprehensive checklist do exist.

This volume opens with a Forward briefly presenting the conversion of the author to an interest in snakes and gives glimpses of her experiences with Bijou, Bettina, Buttons, Bows, Bingo, Bonzo, Bambino, Greeno, and the Elf, names already familiar to those with whom Barbara has shared observations during the past decade.

The Forward is followed by two pages of Acknowledgments, much of which reads like a Who's Who for the Canadian Amphibian and Reptile Conservation Society, and an Introduction which stresses that the public attitude to snakes is improving and that all but three, restricted, Canadian forms are harmless. The first chapters are on "The origin of snakes" which explores, in two pages, theories on their derivation and the ecological situations which may have facilitated it; "The secrets of serpents" which contains a six-page discussion of the place of snakes in myth and religion, and one page on present-day misconceptions; and "Physical characters and adaptions," which includes anatomy and reproduction, and a systematic listing of the 38 forms, comprising 24 species, that occur in Canada.

Four major chapters discuss Canadian snakes species by species. These chapters are divided non-systematically into three which deal with harmless snakes and one on the poisonous forms. "Larger snakes" includes the Black Rat Snake, Eastern Fox Snake, Bull and Gopher Snakes, and Racers; "Medium snakes" details the Northern Water Snake, Eastern Milk Snake, Hognose Snakes, Garter Snakes, Northern Ribbon Snake, Queen Snake, and Rubber Boa; and "Small snakes" covers the Smooth Green Snakes, Northern Ring-neck Snake, Brown Snake, Northern Red-bellied Snake, and Sharp-tailed Snake. "Canadian rattlesnakes" has sections on the Northern Pacific Rattlesnake, Prairie Rattlesnake, and Eastern Massasauga Rattlesnake, as well as a number of rattlesnake-related topics, including rattlesnake bite and a list of Canadian anti-venin depots. The Timber Rattlesnake is mentioned but not given detailed treatment, as the last Canadian specimen was recorded in the Niagara Glen of southern Ontario over 30 years ago and it may now be extinct in Canada. (Since publication of this book, the Ontario government has officially moved to declare the Timber Rattlesnake an endangered species in Ontario.) Persistent rumors of its survival on certain remote, seldom-visited islands in the Georgian Bay area of Ontario and in the southern edge of the Eastern Townships of Quebec have never been confirmed.

The information in these accounts has been woven into a readable text, sometimes enhanced by its individual style. Thus, the checkered pattern of the Brown Snake is said to impart to it "a somewhat tweedy appearance" and the Red-bellied Snake is affectionately referred to as "this elfin little creature." Size, pattern, and color, habits and habitats, number of eggs and young, and distribution are all included, together with additional comments. One unfortunate result of the method of organizing species accounts is the lumping of 10 forms representing five

species of garter snakes together under one heading and allowing them only four pages. These include the most widespread and common snakes in Canada. Three of the species thus grouped are more widespread in Canada than, and equally distinctive from, the Ribbon Snake which belongs to the same genus, but which, apparently owing to its distinctive common name, is discussed separately. (An unkind western Canadian might note that the Ribbon Snake is an eastern species familiar to the Toronto-based author; most of the lumped forms are western.) No keys are given, nor are pertinent contrasts sufficiently emphasized to ensure the separation of those species most easily confused with one another. Technical features, such as scale-count data, have been scrupulously avoided, despite the intimation (p. 40) of their importance in distinguishing species.

The book concludes with chapters on "Snakes as pets" and "Conservation of snakes," and two pages of references. The chapter on pets stresses the too-often overlooked point that some snakes can be extremely difficult to maintain in good health in captivity. Advice covers choosing an individual snake, housing and feeding it, snakes born in captivity, diseases and parasites of snakes, and the problem of photographing snakes. The conservation chapter emphasizes the increased inroads that habitat destruction, pesticides, and highway traffic make into snake populations, and strongly deplores over-collecting. Recommendations for conservation surprisingly condone the biologically dubious practice of "rescuing" snakes from threatened sites and dumping them elsewhere. Particularly regrettable is the omission of any plea for more complete information on distribution, local abundance, and life history. Also notably absent is any mention of the importance of additional research as a basis for sound conservation proposals.

The book is amply illustrated by 21 color photographs and 35 black-and-white figures, most of these photographs of individual species. These, particularly the ones in color, will greatly aid species identification. The diagram of the internal anatomy of a garter snake is a particularly welcome feature as this is rarely illustrated in snake books. Range maps are included only for the rattlesnakes, but these are very useful as they depict Canadian localities for each of the three still-existing forms.

Although this was not intended as a "scientific" book on snakes, the literature has been quite conscientiously consulted and errors of commission are few. Those curious about Canadian snakes, either from fascination or from fear (or both) will find this sincere and enthusiastic treatment a welcome addition to their library.

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Mammals of Waterloo and South Wellington Counties

Text by C. A. Campbell and A. I. Dagg, Illustrations by M. Dyer and M. E. Gartshore. 1972. Available from Otter Press, Box 747, Waterloo, Ontario. 130 pp. $3.00.

Written primarily for the layman and naturalist, this book also has a place with the professional mammalogist. The text provides a valuable contribution at a specific time and place to the history of mammals and the effects of man on them.

Though limited in geographical scope, the format with the keys, taxonomic data, and important identifying characteristics is a useful manual for students of mammalogy. The drawings of the animals and the margin sketches of tracks are for the most part very good. Enough of the habitat is depicted of each species to give the reader an idea of the ecology of the animal. This is a great aid and gives vitality to the book. Drawings of the skulls are excellent.

Life-history data are deliberately sketchy. The purpose is not to present complete life histories; rather, the book is designed to provide historical data. The authors, however, chose to suppress information on scarce species "in the interest of preserving these animals." If the next survey of the area covered in the book is as long in coming as this present one, these species will remain a mystery. Presently scarce species might become extinct or might become plentiful as environmental changes occur. Either way, their presence in 1972 should have been documented.

Some users of this book, particularly those from the scientific community, might be annoyed at the inconsistent use of metric and English units of measure. Lengths are given in inches, weights in grams, or in pounds for larger species. Average measurements of some species from the area are given in metric units.

The book is a valuable contribution to mammalogy in general, and to the history of mammals in a portion of southern Ontario specifically. It is a useful tool and an important time mark in a rapidly urbanizing locality.

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The Snipes: A Study of the Genus *Capella*

By Leslie M. Tuck. 1972. Canadian Wildlife Service Monograph Series Number 5. Information Canada, Ottawa. 432 pp. $7.25.

When the Canadian Wildlife Service launched its Monograph Series with "The Murres" by Leslie M. Tuck, a high standard was set for later authors in the series. Now Dr. Tuck has again contributed to the series and not only maintained but raised the high standard he set over ten years ago. Both books have been awarded the Terrestrial Publications Award of the Wildlife Society.

This book is the product of ten years of field work by the author, mostly in Newfoundland, but also in northern Manitoba and northern Ontario, with additional visits to the southern U.S.A., Bermuda, Venezuela, Ireland, and Holland. The literature has been extensively reviewed even to the point of examining the only known copy of a book published by Frenzel in 1801 to solve a nomenclatural debate; this book is housed at Cambridge.

The text is preceded by a color plate of a chick, a short biography of Tuck, lists of contents, tables, figures, and appendices, a foreword, and a long list of acknowledgments. Part of Tuck's success with this book stems from his extensive use of unpublished data kindly supplied by other observers, and his submission of parts of the book to other experts for critical review prior to publication. The text is divided into three parts: the genus, the species, and populations and man. The first two divisions are a little misleading in that all chapters are based primarily on the common snipe (*Capella gallinago*), especially the Nearctic race (Wilson's Snipe, *C. g. delicata*), and all contain information on other species in the genus and outside the genus. The text is followed by five appendices, a list of references, and a five-part index.

So much of interest is found in the text that I can do little more than hit the highlights. Part 1 consists of the first four chapters. The first, "The Goat of the Bog" includes a discussion of scientific and common names, interesting snipe folklore, and an excellent discussion of the "winnowing" or "bleating" display. Old and new versions of how the sound is produced are discussed. As in all good scientific studies many questions are raised, such as whether supposed differences in the sound are real or merely a reflection of the observer's position in relation to the bird. The fact that females sometimes "bleat" is documented, raising the new question of 'why?'. The descriptions of morphology in chapter 2 are aided by good figures, and made more interesting by relating structure to adaptation. An excellent capsule account of the zoogeographical regions of the world begins the third chapter, on taxonomy and distribution. The use of different symbols would have allowed some of the maps to be combined (e.g., especially figures 32A and B), and perhaps facilitated the addition of maps for the three forms not so depicted. The habitats used for breeding by Wilson's Snipe in Newfoundland, Alaska, and the Hudson's Bay lowlands are described in detail in chapter 4, but that used on the prairies and in British Columbia is not even mentioned. This is partially remedied in chapter 7, where nests are described from Saskatchewan and southern Manitoba. The account of territory in the same chapter is good, but seems out of place. Chapter 6, where further details are given, would have been a more suitable place for this. The use of the term "display arena" (p. 141), apparently in reference to a spot where display between the pair takes place, is unfortunate as this term is usually used synonymously with "lek" as does Tuck later in reference to the lek displays of the Double Snipe (*C. media*).

Part 2 consists of nine chapters on the life cycle of the snipe. Maps help plot migration routes and show weather influences on migration in chapters 5 and 10. The records of 400 observers chronicle spring migration; some (e.g., A. E. Allin, G. J. Smith, L. Terrill) span many years. Others unused are available, but would have been very time-consuming to collect. The breeding season from pair formation to chick care is covered thoroughly in chapters 6 through 8. Extensive data are given, but many questions are again raised, such as the biological significance of the reddish terminal band on the dark tail, and why the male helps care for the chicks but apparently does not brood eggs. Data on food and feeding habits (including habitat and feeding times) are given in chapter 9. The failure of some authors to include grit in their data on stomach contents makes comparisons between studies difficult. Data presented in chapter 12 on parasites and natural mortality are largely from the literature. Extensive lists of published parasite records are relegated to tables, allowing the casual reader easy progress. Five pages of photographs enhance the descriptions of winter habitat in chapter 11. Banding returns indicate that at least some snipe winter in the same area each year.

Part 3, comprising the final two chapters, presents data on age and sex ratios, population statistics, and past and present hunting practices. Dr. Tuck feels that populations are currently in good shape, and management efforts would be too costly and unnecessary at present. Habitat encroachment is more likely to present problems than over-hunting in North America, but there is no real habitat crisis for snipes at present; in fact in some areas man has improved it.

One can find little fault with this book. Few scientists can write a book which combines extensive data with an easy reading style. Leslie M. Tuck is obviously one of those few. His concise easy-flowing sentences, use of simple terminology whenever technical jargon is unneeded, impeccable grammar, and use of tables and figures in the correct places combine to make a readable and informative text. The proofreaders have done a good job

too, with the omission of "i" in "flight" (p. 151) their only obvious slip. A few others show up in references. In three cases (pp. 55, 60, 319) dates in the text fail to match those in the reference list, and one reference (Shulpin 1936, on p. 257) is not listed. In one case (p. 178) the author is listed as Nilsson in the text, Nisson in the references; *et al.* is used twice (pp. 127, 135) where there are only two authors; and a paper by Hume and Marshall is consistently (pp. 56, 89, 205, 257, 350) credited to Hume only. A few additional errors are present. Scolopacidae cannot refer to a subfamily (figure 7) as "dae" always refers to a family; "pintails" is used where "snipes" is intended on p. 91; Nearctic instead of Neotropical on p. 109; northern Manitoba instead of Ontario on p. 150; and Parmalee (pp. 213, 214, 405) should read Parmelee, and Camarque (pp. 296, 422) Camargue. Such errors are minor, and do not detract from the book. Citing articles in *A new dictionary of birds* by author rather than generally referring to the whole book would have aided the reader in following up some points, but as Tuck only used that book in three rather obvious contexts, and the dictionary is cross-indexed well, little problem should result.

In summary, Dr. Tuck is to be congratulated for once again producing a book of which Canadians can be proud. *The Snipes* is a must on the reading list of all serious ornithologists, naturalists, and sportsmen, and will serve as a model for monographs on other species.

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The Harp Seal

By David Terhune. Photographs by Jack Terhune. 1973. Burns & MacEachern, Toronto. 53 pp. $7.95.

Those who buy this book on the harp seal will do so because of the colored photographs. They are excellent, evoking a mood of northern snow and ice-filled water that could scarcely be excelled. There are 16 of them in all, each covering an entire page. Given the beauty and interest of these photographs it is difficult to be greatly moved by the black-and-white pictures which are small, sometimes blurry and which portray much of the same material. (No matter how many lens angles one uses, it is hard to be endlessly varied and original when the background is almost always white or blue and the subject is inherently lumpish and often stationary.)

The format of the book is artistic, with half of each page of text blank and with the non-colored photographs centered on all-black pages. In keeping with this simple style is the text, which gives a brief review of this seal's life history. This is written colloquially, telling the reader such things as, "As far as a seal is concerned, fat is beautiful—and it's warm!" and "When the seals want to go, they go!" There is no discussion of the recent furor over whether this species should be hunted, and if so to what extent.

Since 20 pages of text are too few to allow anyone to discuss a species in depth, one wonders why the preface is so unsuitable. We read there that "Much of the data used in the book stems from research results compiled by this international team" of Danish and Canadian scientists working out of the University of Guelph and that in this book "The data gathered at Guelph—plus that from the Gulf [of St. Lawrence]—is compiled, examined, and pieced together in order to explain some of the mysteries behind this marine mammal." The research at Guelph must surely deal with more profound information than is given here.

Although the text is brief, it is not always clear. For example, anatomical studies at Guelph have elucidated the structure of the harp seal's ear, which although distinctive, is based on the fundamental pattern of the mammalian ear. Terhune describes this structure in the harp seal as being two pairs of ears, inner ones for listening and outer ones for protection. Such a description is simplistic and unhelpful in educating us about this new research. Again Terhune reports (page 3): "Although it is a friendly looking animal, the Harp Seal prefers to be left alone. It even prefers not to mix company with other members of the seal family." Also: "There is no one reason why the Harp Seal is most often found living alone." We can only think that these mammals live as hermits. Yet later on the harp seal is discussed as a social animal living in herds.

This book will prove an aesthetic treat for many people, but especially for laymen who know little about seals.

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Background for Managing Grizzly Bears in the National Parks of Canada

By K. R. D. Mundy and D. R. Flook. Canadian Wildlife Service Report Series Number 22. Information Canada, Ottawa. 1973. 35 pp. $1.00.

This thin book will interest both large-mammal researchers and park users. Most of the text and appendices are devoted to life-cycle and other biological information on grizzly bears in Canada's National Parks. The information presented is based primarily on Mundy's thesis work in Glacier National Park, but supplemented by information from park wardens and other observers, and from the literature. Sections on population dynamics, density, reproduction, longevity, potential mortality factors, habitat, food, movements, and growth are followed by a discussion on attacks by grizzlies on people and management possibilities for reducing the danger of such attacks.

Although the authors are obviously cognizant of the dangers a grizzly can present to a person, they point out that grizzlies will usually avoid contact with humans. Like most contemporary conservationists and bear biologists they look on the "bear problem" as primarily a bear–people problem. Thus, the 12 management recommendations consist of methods of avoiding bear–human contacts and especially of reducing the attraction to bears of such evidence of humanity as garbage dumps.

The book is pleasantly laid out with good photographs, clear figures, and concise tables. The proofreaders have done a good job, with the notable exception of page 11, where three reference dates differ from those in the "literature cited." A typing error on page 24 was the only other mistake I spotted. On two points the book is out of date. The tragic death by a grizzly of a Canadian Wildlife Service photographer in the fall of 1973 in Jasper National Park invalidates the statement that only one person has been killed by the bears in a Canadian National Park. On a more pleasant vein, the addition of Kluane and Nahanni National Parks to the list of Canadian parks adds two more grizzly-inhabited parks to the seven listed by Mundy and Flook.

Let us hope that the research on which this book is based will allow both grizzlies and human beings to thrive in Canadian National Parks for years to come!

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The Moths of America North of Mexico, including Greenland, Fascicle 20.1, Mimallonoidea (Mimallonidae) and Bombycoidea (Apatelodidae, Bombycidae, Lasiocampidae)

By John G. Franclemont. 1973. E. W. Classey, Ltd. and R.B.D. Publications, Inc. North American Distributor: Entomological Reprint Specialists, Los Angeles, California. 86 pp., 11 colored plates, 22 figures. $32.50

Although the second section of Fascicle 20 (Saturniidae) was published earlier than the one here reviewed, we will review the Saturniidae later in the year, in keeping with the plan of the entire work.

It is with the greatest of pleasure that we recommend Franclemont's treatise on the Mimallonoidea and the Bombycoidea to our readers. Its use certainly will be extensive, as here are covered many economically important species such as the "Tent Caterpillars." In the past there has been no authoritative work on the Bombycoidea exclusive of the silk moths, since Packard's monograph covered only the Saturniidae; one had to be content to search through countless smaller publications, each dealing with a few species or genera only. Moreover the nomenclature, even as to superfamilies and families, was unstable to say the least. Many of these problems are solved with the appearance of Franclemont's publication. There remain, of course, some challenging problems as the author himself says in the very readable Introduction; however, it is to Franclemont's indelible credit to have collected them in one Fascicle and made them approachable, creating a solid basis for all further research into the North American Mimallonoidea and Bombycoidea. The author's ideas, expressed in the Introduction, on infraspecific names and newer taxonomic approaches (protein analysis, chromosomes, pheromones) come as a welcome endorsement of much of current practice.

Several details are of special interest:

1. It is good now finally to see an understandable higher taxonomy for the groups involved; the "Classification of American Lasiocampidae" on p. 29 is, to my mind, the "non-plus-ultra." In the same sense, on the generic and specific levels, Franclemont's solutions to sometimes "age-old" problems, like *Phyllodesma,* appear natural and elegant.
2. Most of the new species and genera, properly described in a publication of this type, are from Arizona and/or Texas where the author has collected extensively over the years. Here now we find the fruits of his long silence. It may be said that Franclemont never splits genera needlessly and that everything he does and proposes is well documented and therefore, convincing, a quality, unfortunately not always shared by similar publications.

3. Compared with previously published fascicles it is noteworthy that here no savings were attempted by including an only insufficient number of drawings of genitalia. In this fascicle we find the coverage that we need and expect. The color plates, of course, are of the usual high quality that has become the hallmark of the series.
4. Particularly appreciated are many remarks which have cleared up many and vexing questions in the literature—to mention one: p. 25, the note on Lachneides Hübner.
5. A sample of the genera which needed clarification most would include these: *Tolype*, which required much revisionary work and still needs more (especially in the West) as Franclemont says in the Introduction; *Phyllodesma*, which was broadly revised by Lajonquière but was probably too much split into small groups, now makes good sense after "compactization" with use of all of Lajonquière's propositions; *Malacosoma*, which was already revised satisfactorily by Stehr and is here condensed to a form for everyday use by the fieldworker.

Concerning Ontario, I would add that *Tolype notialis* Franclemont is reported from Rondeau Provincial Park in several specimens (certainly determined by genitalic dissection) and that *Malacosoma californicum* is distributed all over the northern part of Ontario from the Manitoba border to the east, and south to around Parry Sound. In that area, *M. californicum* occurs sympatrically with *M. disstria* which is found not only in "southern Canada" but reaches far to the north (at least as we understand it) as well.

In summation, Franclemont has, with great success, brought together all the material that has seemed such a formidable obstacle to other workers for many years. One can only wish that additional fascicles will show the high scientific standard of Franclemont's publication, and we look forward to his further contributions.

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Alberta Vireos and Wood Warblers

By W. R. Salt. 1973. Provincial Museum and Archives of Alberta. Publication No. 3. Queen's Printer, Alberta. 141 pp. $4.50.

Alberta Vireos and Wood Warblers is the first of an occasional series of publications by the Provincial Museum and Archives of Alberta which is planned to deal with studies of particular families and groups of birds. The book follows on the heels of the popular *Birds of Alberta* and hopes to remedy some of the deficiencies of the latter by concentrating upon distribution, migration, and breeding of vireos and wood warblers in Alberta. In all, 34 species (4 vireos and 30 warblers) known to have occurred at some time within the boundaries of the province of Alberta are discussed. Each species is considered separately, the discussion conforming tt a uniftrh patter in which distribution, nesting, and migration are the main headings. In most instances the discussion is accompanied by a range map for the species involved. The text devoted to each species varies with the information available and varies from $6^1/_4$ pages on the Yellow Warbler, *Dendroica petechia*, to but $^1/_4$ page on the Parula Warbler, *Parula americana*. At the end of the book each species is depicted in color in its fall plumage.

It is unlikely that *Alberta Vireos and Wood Warblers* will meet with the popular success of *Birds of Alberta* since the former is of a documentary nature. Much of the text is devoted to lengthy tabulation of localities in which the species have been recorded and of dates of arrival and departure at specific localities. Although this information is invaluable to the student of ornithology, it hardly makes for exciting reading. In most instances the range maps, based upon the tabular data are well presented, with one obvious exception: on p. 36 it is clear that the map does not coincide with the text. Clearly the legends for the two subspecies have been transposed. In addition it is difficult for the reader who is unfamiliar with the geography of Alberta to pinpoint specific localities since only six place names occur on each map. I suggest the book could be greatly enhanced with the inclusion of a detailed reference map of the province of Alberta. This criticism apart, the book is well documented. The lengthy and up-to-date list of references and sources of unpublished information add a valuable dimension to the book, particularly for the serious student of ornithology.

It is unfortunate that the book does not include color plates of the birds in their breeding plumages. Although the author is correct in saying that good descriptions of breeding plumages are available elsewhere, there is no substitute for having a complete set of good illustrations within a single volume. The illustrations are of reasonable quality, although in the review copy the color rendition is not as accurate as it might be (eg., American Redstart, *Setophaga ruticilla* on plate IX). No scale is given for the birds illustrated and thus it is difficult to gauge comparative sizes. Finally, I am not convinced the illustrations achieve their purpose in making easy the identification of fall warblers (if this can ever be so). A comparison of Audubon's Warbler, *Dendroica auduboni*, with the Myr-

tle Warbler, *Dendroica coronata,* certainly shows the similarity between the two species but the yellow rump of the Myrtle Warbler, an important guide to identification, is not shown. For comparative purposes, and for ease of identification, the illustrations would have been of greater value had the birds been painted in the same pose and to a uniform scale.

Although the major aims of the book are a discussion of distribution, migration, and nesting, Salt has attempted to add interest with a colloquial discussion of behavior, song, and nesting habits. This portion of the text may achieve its purpose, but many annoying statements are made which seem out of place in a book such as this. Surely the days have passed when ornithologists characterize species as being "economically beneficial." Likewise the anthropomorphic descriptions of habitat selection (eg., p. 92) detracts from the book. In most instances the author has been careful to document fact, and yet on p. 35 we find the dangerous and undocumented statement that "the over-zealous promotion and use of chemicals and heavy machinery" has resulted in the destruction of much good Yellow Warbler breeding habitat. Finally, the verbal descriptions of song are so subject to personal interpretation that they are of little value. These criticisms apart, there are features of novel and general interest. The explanation of the scientific name for each species adds an interesting subject to the text. The comments on Cowbird, *Molothrus ater,* parasitism is of general ornithological value and is well handled. Some of the more general comments (eg., role of banding, p. 101) are valid and may assist birders in general in the interpretation of their data.

Generally the book is well produced. Several spelling errors were noted and should be corrected in any future editions. Respect for taxonomic convention should be maintained at all times. Thus generic names should always be capitalized (eg., *Seiurus,* p. 81 and *Setophaga,* p. 112). Finally, the binding is weak and after review several pages have become detached.

Basically, this book achieves its objective, and in so doing makes a valuable contribution to the ornithology of Alberta. *Alberta Vireos and Wood Warblers* will be of most benefit to ornithologists within Alberta, although ornithologists elsewhere may find it useful. The author is to be complimented for the care with which he has compiled his information. This was no easy task, and generally Salt has completed it well.

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Introduction to Herpetology

By Coleman J. Goin and Olive B. Goin. Second Edition. 1971. W. H. Freeman and Company, San Francisco. 353 pp. $8.00.

The first edition of this survey of the state of knowledge of amphibians and reptiles to date was issued in 1962, and it is a mark of its wide use that this revision has been necessary so soon. At the time of its publication it filled a basic void—no English textbook existed which treated these vertebrate classes together, although their study has long been combined.

The notable change in the second edition is that the former chapter on "Relation to environment" has been divided and expanded into two chapters: "Homeostasis" (Physiological exchange with the environment) and "Relationship to the biotic environment," with new material added. The chapter on behavior has been reorganized and updated. There have been corrections and modifications throughout, but the basic organization and titles of other chapters remain the same.

The Introduction sets herpetology in perspective among other biological disciplines, discusses the position of amphibians and reptiles in systematics, examines the species problem, and sketches the development of the study of herpetology. Six chapters discuss structure, origin and evolution, and reproduction and life history, first in each topic for the amphibians, then for the reptiles. The three revised chapters already noted follow. The "Mechanisms of speciation" and "Geographic distribution" treat the two classes collectively. The book concludes with six chapters giving classification down to subfamily, and discussing the characteristics, distribution, and life histories within each group. Examples of included genera and species are provided.

An appendix on classification lists all living and extinct groups to order, and in those orders or suborders having living representatives to the level of families. An additional appendix, in the first edition, giving chromosome numbers for amphibian and reptile species, has been omitted.

No textbook classification can cope with all of the divergent views and fast-accumulating new revisions, but the one presented is as modern and up-to-date as publication deadlines and the inevitable biases of authors permit. Notable deviations from the first edition in classification are the transfer of the Typhlopidae from the lizards to the snakes and the elevation of amphibaenians from a family of lizards to suborder status equal to lizards and snakes.

Order status (Trachystoma) is retained for the sirens although many workers prefer to regard them as a divergent family within the salamanders (order Caudata).

The authors state in their Preface to the second edition that their basic philosophy on the book remains the same, and for some this will pose a major disappointment. It is still planned, as stressed in the first edition Preface, "for use in a one-semester course in herpetology. It is designed for students who have had one year of college biology, but who may have had no more than one year." In addition, the authors were firmly convinced that "the proper approach was to discuss basic biological principles as exemplified by amphibians and reptiles."

In Canada, the few herpetology courses offered are generally at the post-graduate or honors-year level, and a condensed, essentially second-year text can not adequately provide the degree of sophistication required, nor satisfy the need for a detailed reference volume. Particularly disappointing is the meager list of references that concludes each chapter.

Within their basic premise on the most important audience for this text, however, the authors have achieved their aim with skill and quality. Any naturalist interested in a summary of our knowledge of amphibians and reptiles, or in their role in the local or world environment, will find that this volume provides a firm and painless grounding. This is particularly essential when many simplified and stereotyped "popular" concepts of amphibians and reptiles (i.e., that they are obliged to remain at the temperature of their immediate surroundings) have been swept aside by detailed modern physiological and behavioral studies, but remain entrenched in much of the non-technical literature.

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A Book of Insects

By C. P. May. St. Martin's Press, New York, and Macmillan of Canada, Toronto. Illustrated by John Crosby. 1972. 119 pp. $4.95.

Charles May's book is written in an easy, readable style obviously for children in the junior and perhaps in the intermediate grades. The paragraph on the jacket cover builds the book up well, so much so that I misconstrued its intent at first. I envisioned great emphasis on the interrelationship between man, society, and insects which I deem of vital importance, but I was disappointed. Admittedly this interrelationship was shown in the articles on some particular insects, but only briefly. The book would have been improved if it had been more geared in this direction.

At first glance I felt that the book contained superficial explanations of the insects but as I read more I found the explanations to be poignant and worthwhile from a teacher's point of view. Since the book is intended for children, then perhaps more words and diagrams are needed to explain the extraordinary parts of different insects and their purposes: terminology such as "proboscis" and "halteres" could have been elucidated. (The introduction does cover many points concerning insects that are necessary for a general understanding of the content of the book.) If the intent of the book is to introduce the child to these common insects and have him do further research as his interest directs him, then I would accept the book as it is.

The illustrations in the book were sometimes disappointing. I feel that the diagrams should have been done in color. The children then would have been better able to assimilate information on a particular species and to identify it. I am sure that some children would not always be able to recognize the insect mentioned in the book and drawn in black and white as the same insect present in their backyards.

Looking at the book from the point of view of its value in the classroom, I can see its being useful to the teacher and to students already interested in, and knowledgeable about, insects as a quick and concise source of details on the appearance and habits of individual species. As a research book, however, I feel it is lacking in detail, both written and drawn.

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Macrolichens of Denmark, Finland, Norway and Sweden

By Eilif Dahl and Hildur Krog. 1972. Universitetsforlaget (Scandinavian University Books), Oslo, Norway. 185 pp. Illustrated. Price Nkr 46.00 (about $7.90 Can.).

There is a growing number of amateur and professional naturalists and biologists desiring an aid to the identification of lichens, especially the larger ''foliose'' and ''fruticose'' types (commonly considered together under the term ''macrolichens''). Any ecologist working in the north, particularly with projects in the vast sub-arctic ''lichen woodlands'' and in the arctic tundra needs to know the names of lichens occurring in his or her study plots. This is simply because lichens often form the dominant vegetation there.

Unfortunately, there is no identification manual to the northern Canadian lichens, especially one approachable by non-lichenologists. It is therefore very gratifying to see the appearance of a book in English devoted to the macrolichens of Denmark, Sweden, Norway, and Finland since the great majority of species occurring there also can be found on this side of the ocean. Only about 60 out of the approximately 430 species treated in the book are not found in Canada. Of course, we have many species here which do not occur in Fenno-Scandinavia, mainly in the coastal regions of Nova Scotia and British Columbia, but in most parts of Canada this book will serve extremely well.

The book essentially consists of keys to genera followed by diagnostic keys to species. As is often the case, finding one's way through the generic key is more hazardous than following the species keys. It will be confusing, especially to beginners, to find that members of the *Cetraria islandica* group will not be found under the choice ''Thallus dorsiventral, foliose or fruticose, in the latter case with flattened stems,'' but under an alternate, very long and rather confusing choice not very easy to picture. Other sources of possible error are less consequential. For example, in *Alectoria nigricans* it is the cortex, not the medulla which reacts C+ red and PD+ yellow. These problem spots, fortunately, are few.

In large genera, the species key is often introduced with a short synoptic key to enable the user to avoid being lost in a forest of choices. I have found the keys to species reliable and easy to use. Those unfamiliar with lichenological terms are provided with a concise glossary in the back of the book. A list of common synonymns is also provided along with a synoptic classification chart and a list of author abbreviations.

The two authors, Eilif Dahl and Hildur Krog, are experienced field workers with years of observation in Scandinavia, as well as in the North American North. It is therefore not surprising that their approach is essentially pragmatic. They do not hesitate to key out species belonging to different genera within a key to a particular genus if the species are generally similar and could be confused. For example, with the *Parmelia* key one will find such *Parmelia*-like species as *Cetrelia olivetorum, Hypogymnia intestiniformis, Cetraria commixta,* and even *Nephroma parile*. *Pannaria* and *Parmeliella* are treated as separate genera but the species of both genera are keyed out together. Difficult genera, still poorly understood even by experts, sometimes include species in the ''collective'' or broad sense. *Usnea* is a good example.

While most of the illustrations are very good and will undoubtedly be helpful, many are rather poor. The reindeer lichens are all depicted as having pointed apices, which they do not. The *Stereocaulon* drawings are rather sketchy and often do not closely resemble the species they are supposed to depict (e.g., *S. glareosum* and *S. alpinum),* although I certainly concede that the best of artists would have a hard job with such difficult subjects.

The main body of the text is preceded by a general introduction to lichens with sections of morphology and chemistry (both with a slant towards being helpful in identifying the plants) and a section on lichen distribution in Scandinavia. A list of the chemical reactions of a majority of the species will undoubtedly be very helpful to most students. In the interest of brevity, microchemical identification procedures are not presented. Instead, references are given to books and articles where the reader can find these procedures.

A list of the color reactions of 26 lichen substances is presented and will be of great value as long as users realize that often there are several substances within a single species which may give confusing combinations of color reactions. (Two minor errors in the list should be noted: protocetraric acid is KC+ orange-pink, and strepsilin is KC+ dark blue-green).

Until a book appears which specifically covers the macrolichens of boreal and arctic Canada, this volume will certainly be extremely useful to those in Canada interested in northern lichens. I recommend it highly.

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Environment

Nature in the Urban Landscape: A Study of City Ecosystems

By Don Gill and Penelope Bonnett. 1973. York Press, Baltimore. 209 pp. $12.00.

Urban ecology is a new field in biology, with the first-ever conference on urban wildlife held in Amherst, Massachusetts, in November 1973. It is a field well launched by this interesting book. Although much research in urban ecology is recent, even so the authors have been able to draw information from over 450 fully cited references. The book is largely a readable synthesis of research on plants and animals that survive in cities.

The book begins with a discussion of the physical characteristics of cities (reduction of vegetation; less radiation and wind; more heat, cloud, and rain; and much more pollution by gases and particulate matter than is found in the surrounding countryside). It continues with a discussion of the adaptations of plants and of animals, which enable them to take advantage of this peculiar ecosystem. Some birds construct suitable nesting places in buildings while others seem completely dispersed by such structures.

To illustrate the city ecosystem, two chapters are devoted to the cities of London, England, and of Los Angeles. Miss Bonnett, as a native of southeastern England, has provided citations from many British works probably new to Canadian readers. These include excellent data from the active natural history groups which for decades have documented items of natural history in English cities. The chapter on Los Angeles is much less balanced, dealing almost entirely with the surprisingly large number of coyotes living within the city limits. This slant is understandable since the chapter is based on Dr. Gill's Master's thesis on Los Angeles coyotes; but it may leave the reader curious about other ecological facets of this city.

The final section of the book details how wildlife species have been encouraged to live in various cities and how these species can be managed if they become pests. Institutional grounds, railway and hydro rights-of-way, cemeteries, and derelict land can so be planted with attractive shrubs that they serve as both cover and food for wildlife. Ponds and hedgerows will help to protect the animals from human beings because people, of course, must also be educated to appreciate the wildlife.

This book should be required reading for all city planners and city managers who never before have had the opportunity to consider such a core of ecological facts. It will also interest naturalists and most ecologists because of the breadth of the material, and perhaps even doctors. Did they know before this that city dogs have a higher frequency of pulmonary disease than do rural dogs, and that carcinoma of the tonsils is also prevalent in city dogs?

Nature in the Urban Landscape is short, with fewer than 160 pages of actual text, most of which deal with animals rather than with vegetation. It includes the scientific names of the discussed species as well as illustrative maps and photographs. Hopefully it will form a basis for much future study. Although this book is wrong in stating in the Preface that the first study of urban wildlife in Canada was initiated in Edmonton in 1971, it is accurate in stating that there have been few such Canadian studies.

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What's under a Rock

By Robert Gannon. 1971. Illustrations by Stefan Martin. E. P. Dutton & Co., Inc., New York. Standard Book No. 0-525-42475-x. Published simultaneously in Canada by Clarke, Irwin, & Co. Ltd., Toronto and Vancouver. viii plus 122 pp. $4.95.

This book contains a marvellous arrangement and collection of interesting facts and observations about the small "crawlie-crawlies" one can find under a medium-sized rock in his own back yard or nearby field.

Mr. Gannon has a fascinating style of writing and I think it apt to quote from the beginning of the first chapter: "Tip up a rock—almost any that has been resting for some time in the woods, in a park, in a meadow. Sometimes the ground is alive . . .", "Lift another rock and the world it covers seems deserted." "But all rocks have certain things in common, and one that is 'typical' that can be used as an example of what you may see under a slab of stone in the backyard or nearby woods or city park, isn't too hard to find." "Such a typical rock is the one this book is about. It happens to be in New York State, ninety-seven miles north of New York City. It's on my farm, about a half mile from the house. I've been watching it for about five years now, and I think I know it—and the world it hides—pretty well. "The rock is as big around as a garbage-can cover. It rests forty feet up the side of an open woodland hill facing south . . . ."

With that introduction, Mr. Gannon takes us back into the history of where the rock came from, how it got to where it is, what's happening to it and around it now, and what will probably happen to it in the years to come.

The book is interestingly chaptered as follows: The Rock; In the Soil; Weather; Earthworms; The 'Pedes'; Salaam, O Cockroach; The Under-Rock Community of Crickets, Spiders, Beetles; Three Communes; End of a Cryptosphere; Appendix: How to Stalk Bugs; and Further Information.

But despite these praising comments and interesting chapter titles, the book is full of errors. I list here a few: p. 8: Drawing. A scorpion is drawn, not a pseudoscorpion. p. 10: "Springtails . . . undergo no metamorphic change." But springtails do! It's called a gradual or incomplete metamorphosis. p. 14: "The human hookworm . . . grows to a yard or more . . .". In fact, however, rarely do they grow to more than even 15 mm in length. p. 28: He wrote that the pill bug or sow bug lives as far north as the Arctic Circle. They are not known even from as far north as 60°. p. 36: "A worm . . . holds the title of World's Largest Invertebrate." Many invertebrates are longer, heavier, and thicker (e.g., giant clam, jelly fish, squids). p. 41: The suggestion is that the clitellum of the worm hardens and slides along and off the worm, but it is really the mucus ring produced by the clitellum that slides off. p. 45: ". . . centipedes . . . sting . . ." They do not—they bite! p. 56: It is suggested that cockroaches spread disease. This, however, has never been proved. p. 58: It is stated that cockroaches live as far north as the Arctic Circle, whereas the north shores of Lake Superior are the northern distribution limits. p. 81: He wrote that only the female black widow is poisonous, yet both the male and female are poisonous.

There are many, many more errors. In this case, I blame the publishers for not submitting the manuscript to one or more biologists for comments. I sent a complete list of errors (with suggested corrections) to the publishers, with the comment that the book be re-issued. I consider that this book contains much valuable interpretive biology and is worth re-issuing. I feel that the book is usable to a broad age group of youngsters from about 8 to 15.

The book has a very attractive dust cover, and is bound in a light-brown buckram. The printing is large and clear on non-glossy paper. I found no typographical errors. The "Further Information" at the end of the book directs the reader to many interesting books and articles.

A corrected version of this book will be worth its price.

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Other Books

CBE Style Manual

By Council of Biology Editors, Committee on Form and Style. 1972. CBE Style Manual. Third Edition. American Institute of Biological Sciences, Washington, D.C. 297 pp. $6.00 (US).

Review reprinted in shortened form (with permission of the Ecological Society of America and the author) from Ecology 54(5): 1188. 1973.

Most American biological journals have explicitly accepted the CBE Style Manual. It is recommended on the last page of each recent issue of ECOLOGY and ECOLOGICAL MONOGRAPHS; this Instructions to Authors section is essentially a one-page (manifestly inadequate) summary of the book which authors, particularly beginners, should study *before* preparing a manuscript for our journals.

The third edition, far more complete and useful than the first two, was prepared by the Committee on Form and Style of the group now called the Council of Biology Editors. While the continuing objective "has been to encourage the standardization of editorial practices in biology," many more authors than editors will use this guide. Its organization was designed primarily for authors; it follows the ontogeny of a biological paper step by step from conception to post-publication. This semblance of plot development makes the valuable but perhaps uninspiring details more readable and meaningful. One even encounters gems of biological humor among the "examples of faulty writing." The quoted recommendation for a certain book claimed to "fill a much-needed gap" is not one that the ESA Editorial Board would apply to the CBE Style Manual.

The reader begins with "planning the article," then considers excellent directions for "writing the article" which stress conciseness and clarity, and "mechanical conventions." Chapter 4 on "style in special fields" takes up 65 pages or nearly a fourth of the total text. Fourteen special fields are represented among the subheadings. Although ecology is not one of them, much information required by ecological writers appears in the chapter. The special section identified as "Botany, Zoology and Microbiology" deals entirely with systematic nomenclature and keys. Other sections include symbols

and abbreviations used in thermal physiology, respiratory physiology, and statistics. Mathematical formulas and equations receive brief coverage. The key sentence in a 2.5-page discussion of style in statistics is ''Emphasize biology, not statistics.''

Chapter 5 on preparing copy is the most useful 40 pages to authors of journal papers. They should have their typists read the following chapter before starting in the manuscript. After that is a brief but important chapter on the review process; it should be digested by referees, authors, and editors. This is one of the very few places in the manual where publishing ethics (a subject in which a generation gap of indoctrination seems to exist) is touched on. A later chapter depicts the proofreaders' marks needed by authors in correcting the typeset version. The final chapters are very useful for reference, and look toward standardization of usage. A long list of ''terms used by biologists in highly specialized dixciplines'' contains few distinctively ecological words. For example, there are none combining the roots ''eco-'' or ''-climax.'' Authors should not be diverted from a practical 26-page reference list because of the forbidding title ''Copy editor's guide to abbreviations and symbols.'' This distinguishes the standard ones, which may be used without definition, from the nonstandard ones which should be defined at first mention. Use would be easier if those references by chapters and tables had been given by page numbers instead.

This list, too, has a reductionist bias—''kilometer'' is absent, and to find ''hectare'' one must know the abbreviation. ''Kilogram-calories,'' the book says, must be converted to joules. However, environmentalists may take comfort that the book's pages consist of 100% recycled paper, with handsome results.

The complexity of the manuscript flow-chart shows that authors can actually speed up acceptance and publication of their papers by following directions in literal detail—first, those on our Instructions to Authors page and the Style Manual, and finally, those reaching him with the proof.

Every ecologist who publishes should have access to at least one good style manual. If he has only one, the CBE Style Manual, since it is officially accepted and adopted, should be that one.

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Science and Politics in Canada

By G. Bruce Doern. 1972. McGill-Queen's University Press, Montreal and London. International Standard Book No. 0-7735-0108-8. xiv plus 238 pp. $12.50.

The author wrote that the primary focus of this book was to assess and, partly, to explain behavior in the science and government relationship. He set three objectives, and these are implied in the title. The first objective was to decide and evaluate the evolution of the structural machinery by which Canadian scientists, governments, and politicians have sought to establish contact with one another. The second objective was to examine the Canadian scientific community as a political system itself. And the third objective was to examine what science policy-making might tell us about the nature of science decision-making in Canada. All objectives are attained.

The book is divided into eight chapters and four appendices. The chapters are entitled (1) National Research Council: Centre of Conflict, (2) Bureaucracy's Views of the Science Secretariat and Science Council, (3) Science Secretariat and Science Council: Structure and Personnel, (4) Politics of ''Big Science'': The ING Affair, (5) The Political System of the Scientific Community, (6) Science and Politicians, (7) The Nature and Meaning of Science Policy, (8) Science and Politics and the Nature of Decision-Making. The appendices are entitled (A) A Politicial Assessment of the Senate Report of Science Policy, (B) National Research Council and Medical Research Council Grants to Universities, (C) Summary of Goals of Six Professional Associations, and (D) Federal Government Expenditures on Scientific Activities 1958–59 to 1970–71.

Reading this book as a biologist, I felt strongly dissociated from most of the ''action'' between scientists and politicians, and between the various science councils and Science Secretariat involved with government committees, and the reason is this—almost the whole of Canada's science policies have been, and are being, developed with and for the physical scientists, with problems centering around the ''big science'' situations (e.g., the Arrow project, the Intense Neutron Generator project, and the Queen Elizabeth II telescope). That this situation has at least been recognized (even if nothing is ever done about it) is seen (p. 600) in Volume 2 of *A Science Policy for Canada* where it is stated, ''. . . we feel that in the 1970s special attention should be given to the social sciences, the humanities, and the life sciences.''[1] Doern

[1]After this review was written the Throne Speech indicated that there would be three councils — Natural Sciences Research Council, Social Sciences and Humanities Research Council, and the Medical Research Council (*The Ottawa Journal,* p. 33. 28 February 1974).

did not draw similar attention to this fact. Doern did draw attention, however, to numerous problems affecting scientists and science organizations, and commented on these problems. I feel that the clearest way to indicate the scope of Doern's analysis is to quote a few sentences: "The main thrust of the criticism of the NRC is that it has been inflicted with a familiar organizational illness, goal displacement." (p. 21); "The notion of conspicuously successful programs may be an even more critical point for science-related programs, because, as will be noted later, the Treasury Board and the politicians have a highly utilitarian concept of science." (p. 25); "In general then, the bureaucracy's view of the new science policy machinery was characterized by a mixture of suspicion and uncertainty." (p. 74); "Most [Science] council members I interviewed have neither the time nor the inclination to be anything approaching a grass roots 'M.P.' for science." (p. 99); "Nuclear physics had become a symbol of scientific status and every self-respecting university thought it had to have one of these big machines." (p. 111); "The ING[Intense Neutron Generator] represents the first significant occasion where Canadian scientists became involved in a process of group politics, in contrast with the previously prevailing structure of a governmental body dealing with one academic scientist at a time." (p. 122); "In an interview in 1968 with the *Globe and Mail*'s science writer, David Spurgeon, three presidents of professional associations commented upon the developing view that scientists could not longer remain politically aloof." (p. 127); "To discuss the National Research Council's approach to science policy is, in part, misleading because the term 'science policy' had little currency throughout most of NRC's history. It is a term of recent vintage, originating in the 1960's, and its meaning is still highly ambiguous." (p. 167).

It becomes evident after reading the above quotes why neither scientists nor politicians trust one another, and why the science councils and Science Secretariat have trouble dealing with political committees. The Chemical Institute of Canada and the Canadian Society for Chemical Engineering (quoted in part here from Volume 3 of *A Science Policy for Canada*, p. 805) were moved to state: "It is our view that Canada does not have, and has not had, a coherent science policy. The *de facto* science policy has been the sum of the individual policies of the various public and private sectors."

Doern wrote this book ". . . with the hope that it will be read by both the specialist and the lay reader . . ." (p. xii). I have my doubts, however, that many lay readers will pick up the book and digest the information in it. There is too much information, and there are many long sentences which have to be reread several times in order to comprehend them.

The printing is clear and well-spaced on the pages. The binding is black buckram, and the title printed on the spine is legible from a distance. I found no typographical errors. Footnotes are copious, but a list of references, which would give a clearer view of the material cited, is lacking.

The book is well worth its price. I recommend it to all scientists and politicians who, if they are not concerned about the relationships between science and politics now, should become so!

References

A Science Policy for Canada. Report of the Senate Committee on Science Policy. (Chairman: The Hon. Maurice Lamontagne, P.C.). Volume 2. Targets and Strategies for the Seventies. 1972. Information Canada, Ottawa. pp. v plus 329–608.

A Science Policy for Canada. Volume 3. A Government Organization for the Seventies. 1973. Information Canada, Ottawa. pp. iv plus 609–902.

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Wandering Lands and Animals

By Edwin H. Colbert. 1973. Clarke, Irwin & Company Limited, Toronto; E. P. Dutton & Company, Inc., New York. xxi & 323 pp. $14.50 (Canada).

In his preface, Dr. Colbert states that he has written this book for the "general reader" and that this "has not been easy." For the general reader with a natural history background I would say that Dr. Colbert has been relatively successful in producing a readable essay on a difficult subject. Scientific jargon has been held to a minimum and while scientific names are unavoidable, numerous good drawings illustrate most of the animals to which he refers.

Scientifically the book deals with two very different subjects—the vertebrate fossil record and aspects of continental drift or, in geological terminology, plate tectonics. In general, Dr. Colbert's discussion of the fossils and where and when the animals occurred, is excellent. Chapters 9 to 12 which deal with the Cenozoic to Recent times and discuss land bridges, isolated faunas, and the effects of the "Ice Age," I found of particular interest.

Earlier chapters deal with earlier times, with many references to drifting continents. The evidence supporting the theories concerning continental drift is lucidly presented and should be understood by the general reader. But when Dr. Colbert attempts to support and combine the continental drift theories with the fossil record (the first eight chapters), he becomes vulnerable to a number of criticisms. On p. 187 he states "One cannot be dogmatic about these problems of continental relationships and faunal distributions in the far distant past. It must be recognized that our view of the earth and of life in those distant epochs of earth history is still incomplete and

fragmentary, and we must wait for time and future discoveries to clarify the picture.'' I couldn't agree more, and it is unfortunate that Dr. Colbert did not follow the advice presented in this statement.

In reading the first eight chapters, one gains the distinct impression that Dr. Colbert is trying the so-called ''hard sell'' for continental drift and that he is trying to fit the fossil record into preconceived continental configurations. One example (of many) should suffice. Much is said about the fossil *Lystrosaurus*, and several chapters are largely devoted to this one Triassic genus. On p. 72, figure 31, a map of continents forming Gondwanaland is presented with the range of four fossil genera, supposedly indicating continuous distribution, superimposed. Nearly 100 pages discuss these relationships in a general way. Most of the discussion centers on *Lystrosaurus* and its presence in Antarctica, India, and Africa. The statement is made that these continents must have been broadly and continuously in contact because of the fossil evidence. The lack of *Lystrosaurus* in South America is scarcely mentioned and not until p. 119 is the fact that *Lystrosaurus* is known from China mentioned. This does not fit Dr. Colbert's ideas and he suggests that the presence of *Lystrosaurus* makes it ''quite possible that China and even Indochina were integral parts of Gondwanaland.'' This is *not* shown or indicated on p. 72 nor in figure 31 where his main evidence is presented.

This type of seemingly purposeful omission of contrary evidence or of forcing the evidence—in this case playing continental shuffleboard—detracts greatly from the book. There are many examples of this, any one of which could be considered minor, but together they distinctly lessen the credibility of an otherwise interesting work.

In summary *Wandering Lands and Animals* presents a good general discussion of the major steps in vertebrate evolution in easily readable language, but the scientific interpretations related to animal dispersal during different periods are questionable, and in this respect the book has little to recommend it.

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One Woman's Arctic

By Sheila Burnford. 1973. McClelland and Stewart Limited, Toronto. 222 pp. $6.95.

A twin-engined Otter passes over Lancaster Sound heading for Pond Inlet, an Eskimo settlement on the northeast coast of Baffin Island, its pilot an Eskimo, its passengers an Eskimo mother with her baby asleep in her hood, four French-Canadian construction workers, the author and her artist companion. So we begin *One Women's Arctic*, an account of two summer periods spent in the Eastern Arctic.

The title is aptly chosen. Sheila Burnford makes no apology for the fact that she is not presenting a detached view of northern life nor a scientific account of the native flora and fauna. Instead we have an easy, relaxed account of what might be viewed as a vacation trip, although the author was partially funded by a Canada Council grant to study Eskimo games during her visits. The reader meets various Eskimos, Kabloonahs (White people) living in the north for one reason or another, dogs, snowgeese—in short, a mixture of events, customs, and scenery presented in the pleasant tones of a film travelogue. There is no sense of frustration or foreboding at the change brought by mechanized civilization, no missionary zeal; indeed the underlying theme is that of respect for nature and admiration for the Eskimo's extraordinary ability to adapt to change in the twentieth century.

The average reader is an amateur anthropologist, whether he admits to the fact or not. Most leisure reading is motivated by our curiosity about social relationships, institutions, customs and characteristics of our own and other cultures. When we read a mystery set in an English aristocratic circle, a pioneer family saga, or an exposé of the advertising industry, we are satisfying our innate anthropological interests. *One Woman's Arctic* caters successfully to this human need. On her second visit to the area she actually takes the reader on a ''dig'' to Button Point where a priest was excavating wooden artifacts of the Dorset culture (the Dorsets, originators of the igloo, lived in the area between 800 B.C. and 900 A.D.). Two chapters are devoted to the enthralling experience. ''There is something totally absorbing about never knowing what the next scraping will reveal, something that has not seen the light of day for hundreds of years, something inexplicable; or so curiously touching that one cannot help imagining oneself in the place of the human being who made this little blade, that awl.''

This ability to imagine oneself in another's place must have helped the author overcome the considerable obstacles of language and lifestyle in the North. She sees herself with detachment too, giving us amusing glimpses of a middle-aged woman struggling with her camera on a sled, or lying in a tiny tent with seven other sleeping forms. Welcoming a chance to accompany any expedition, whether with an ornithologist, archaeologist, or an Eskimo hunting party, brings her various experiences. When not busy on trips or attending functions at the

village of Pond Inlet, she reads accounts of interesting historical figures, and introduces us to the strange "Pibluktu," a hysterical condition experienced in the far North.

Sheila Burnford obviously has a deep-set romantic streak. Her previous book *Without Reserve* recounts her stay in remote Cree and Ojibwa settlements, thus her remarks on the relationship between Whites and Eskimo, and Whites and Indians are based on first-hand knowledge. Before that she took a trip to Antarctica in a Chilean ship, studying birds and making a pilgrimage to Scott's settlement. Born in Scotland in 1918, she came to Canada in 1948 and settled in northern Ontario, where she wrote the immensely popular *The Incredible Journey*. Sheila Burnford is one more example of an immigrant from the Old World with an enthusiasm and sense of appreciation for our country too often found lacking in native-born Canadians.

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Science, Scientists, and Public Policy

By Dean Schooler, Jr. 1971. The Free Press, New York. 338 pp. $3.50 (clothbound).

Many books on social sciences leave the reader feeling that he has learned little new, that he could have constructed the same analytical framework himself, and that with some careful thinking, he could have formulated the same conclusions with more clarity. This frustrating experience may be particularly true for those who have been indoctrinated by the language and logic of the natural sciences, and who wish to use any new knowledge, not only to understand particular situations, but also to predict their future development. I am not sure whether Schooler's conclusions have that predictive power, but —notwithstanding their somewhat obtuse formulation— they do provide the type of insight that is not self-evident, and which seems to have validity beyond the actual situation from which it was derived.

Schooler has begun to unravel the complex role of science in government by analyzing, from public documents, the influence that scientists have had on the formulation of American government policy during the period 1945–1968. From the outset, he rejects the view that politicians are using science more and more to cover contentious political issues with an air of respectable scientific objectivity, and that science and government are uniting in a way that is hostile to democracy. Instead, he asserts that the scientific approach to policy making is possible and desirable, and that scientists must help policy makers to act more "rationally." In Schooler's view, scientists can give a true picture of their physical and social environment, and they have the capability to foresee the future of social relationships, politics, and technological development.

Schooler's study concentrates on the "science content" of 20 specific policies dealing with mineral extraction, social security, government organization, foreign relations, disarmament and arms control, foreign aid, transportation, agriculture, trade and balance of payments, transportation safety, antitrust, conservation, pollution, fiscal and monetary matters, health, defence, weapons, weather, space, and science. For the purpose of his analysis Schooler considers scientific knowledge to be "empirical, specific, replicable, verifiable, and sometimes quantifiable" (p. 27). By "scientists" he refers to physical as well as social scientists, including systems analysts, economists, behavioral scientists, statisticians, and engineers. Although Schooler admits that it is difficult to measure the influence of scientists on policy matters, he nevertheless feels that their influence can be assesssed and described with a fair degree of accuracy.

As the basis for analysis, Schooler groups the 20 policies in four "policy arenas": the self-regulative, redistributive, regulative, and distributive. This framework, which was originally established by Eyestone and Theodore Lowi, is helpful and will be explained briefly, together with Schooler's main conclusions.

In the *self-regulative arena*, private economic groups shape their own policy, and they do so with Congressional support coupled with either the acquiescence or impotence of an executive agency. In the Unites States this arena contains, among others, the petroleum, coal, and other mineral extraction industries. Schooler found that the relevant government scientists have minimal influence over national policy and that scientific considerations have very little to do with the formulation of policies.

The *redistributive arena* is principally concerned with the redistribution of wealth, well-being, power or prestige, from "have" to "have-not" groups. This arena contains a great deal of conflict and competition, and policy matters tend to involve the highest levels of the Executive Branch. Schooler observes that the arena responds more to polemic than to dispassionate science. In terms of scientific expertise, the redistributive arena is typically the domain of the social scientist, but his activities may be more of a threat than a help to the policy maker in that he may challenge the value of political criteria for solving social problems and thereby expose

the weaknesses of the prevailing political system. Moreover, Schooler feels that many policy makers have little respect for the social scientist whom they see as less competent than "hard" scientists. Schooler concludes, that for all of these reasons, neither social nor natural scientists have had much influence on the redistributive policies dealing with social security, internal government organization, foreign relations, disarmament, arms control, and foreign aid.

In the *regulative arena,* government becomes an intervening actor who inserts and enforces his own preferences in social choice. With such an active role, Schooler finds that government has tended to use scientists mainly to bolster and justify government action. The scientist does not participate as a policy maker, but rather as an advisor, or as the provider of the "technological fix." His influence has therefore been restricted to those areas where regulation pertained to a specific sector, and not to the public at large. Policies that depend on behavioral changes of the population as a whole meet with considerably less success, and Schooler sees this dilemma as an additional obstacle to the influence of social scientists in policy formulation.

In terms of initiative, Schooler demonstrates that the actual impetus for regulative policies comes from outsiders whose influence is determined by their scientific reputation, regardless of whether their policy activities are within their field of competence or not. Schooler mentions the policies dealing with civilian control over nuclear energy, pollution, and conservation as examples, and he shows that in certain instances the vested scientific interests within the U.S. government bureaucracy have been hurdles rather than help in establishing new regulatory policies.

Once the government has been dragged in, however, it does need scientists, but their influence has been moderate with respect to the regulative policies on pollution, trade and balance of payments, conservation, antitrust, and transportation safety. With respect to regulatory policies on fiscal and monetary matters, however, the influence of economists has been moderately high.

In the *distributive arena* government distributes benefits to groups who are generally not in competition with one another, and government has, in principle, no need for scientists in this area. Private enterprise, however, often wants scientists to become involved in that their knowledge and discoveries become part of the general packae of benefits. Schooler stresses, however, that the client sees the scientist as a servant whose task it is to achieve immediate and tangible results, and the private sector tends to resist any effort on the part of the government scientist to become an active participant in the policy process. Schooler concludes that mainly for these reasons the influence of scientists in the formulation of U.S. policies on agriculture and transportation has been moderately low. In fact, Schooler points out that the political character of distributive policies in the United States is so strong that planes and dams are more often than not built against scientific objections.

There are two categories of distributive policies, however, where the influence of scientists in the United States has been high or moderately high: communal security (weather, weapons, and health), and government enterprise (science and space). Once more Schooler finds that the greatest policy influence goes to those scientists who can provide the technological fix. Thus, chemical tests on the tar content of cigarettes leading to particular kinds of labelling are acceptable, whereas policies prohibiting citizens to smoke would be rejected.

With respect to the entrepreneurial area, Schooler reports that American scientists have been particularly influential in those parts of the distributive arena where the government itself has become the chief entrepreneur, as is the case in space exploration and the support of university science. He notes that the distribution of benefits in this part of the arena resembles a pork barrel where ("hard") scientists have been given the privilege of dividing the pork among themselves, perhaps to the detriment of the social sciences. From this observation, Schooler concludes that the policy influence of scientists is highest in those areas where their own vested interests are threatened or rewarded.

In summary then, Schooler found that the influence of scientists on the formulation of U.S. government policy has been least with respect to self-regulative and redistributive policies, and some distributive policies (agriculture and transportation). In general, one concludes that scientists are needed either when government confronts a hostile interest or decides to fulfill the demands of a significant group in society. All in all, the reader will agree with Schooler's general conclusion (p. 285) that "scientists have rarely foisted anything on society that its policy makers, citizens, or politically significant groups did not feel they wanted or did not encourage."

The book ends with a brief review of "future issues" such as genetic engineering and social studies of the legal system.

Editorially, the book has many shortcomings. It is poorly written and badly edited. The use of the split infinitive seems to be deliberate, and the irritating use of an apostrophe in the genitive case gives the text an unnecessary harshness. These habits, combined with incoherent run-on sentences and occasional word omissions, make certain sentences incomprehensible. The text is repetitive, but the tables and footnotes are helpful.

Ideologically, Schooler's philosophy smacks of scientific totalitarianism in that the author seems to advocate a society where conflicts would be avoided by means of a rigorous scientific ideology, whose claims would be total. Schooler implies that in our society the "scientist" is the only one who really knows what is going on, simply because he cultivates an objective consciousness. But the

ideology of scientific objectivity tends to ignore the fact that the roots of scientific policy making are as subjective as "ordinary" politics. After all, scientific policy making is based on the ability to present to oneself or to others, the present state and probable future course of relevant events, and as was explained so clearly by Sir Geoffrey Vickers in his book *The Art of Judgment*, this type of reality judgment begins with the selection of what is relevant, and this question of relevance is a matter of valuation rather than measurement.

Technically, Schooler's analysis seems to be incomplete. It stops at estimating the level of policy influence on society. Seen in this light, it seems that the overall influence of economists, particularly through their influence on fiscal and monetary policies, has been more fundamental and more widespread than the influence of any "hard" scientist, notwithstanding Schooler's lament to the contrary.

In spite of these shortcomings, Schooler's categorization of science in government is interesting. First of all, the influence of "scientists" (or technocrats) on traditional "political" policy matters in the United States seems to have been far less than some sociologists fear. On the other hand, Schooler has shown convincingly that governments need scientists, particularly in the regulative arena, to provide justification for government action. These findings might strengthen the view of such authors as Theodore Roszak that "the certified experts belong to headquarters." Schooler has provided further evidence of the significant political influence of scientists outside of the government bureaucracy. But above all, his analysis has highlighted the political differences that exist between science in government departments such as agriculture, communications, urban affairs, or nuclear energy.

It is tempting, of course, to apply Schooler's findings to some Canadian situations. For instance, after reading Schooler's study one has a better appreciation of the policy role of advisory councils to government research activities, and one realizes that policy conflicts may emerge between "old" councils and "new" government structures. One wonders also whether the overall policy role of a department such as the federal Department of the Environment, essentially consisting of former natural resources departments, will tend to shift from the distributive arena to the regulative arena, and what effects such shifts would have on the scientific programs of such a department. A more fundamental question may be whether there are psychological differences between scientists working in the regulative arena and those working in the distributive arena, and if so, to what extent such differences would thwart or reinforce any shifts in departmental policy roles.

Some of these suggestions may be an overextension of Schooler's findings. Yet they seem sufficiently relevant to suggest that a study about the influence scientists have had on the formulation of federal policies in Canada would be of interest and benefit to scientists and policy makers alike.

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Dance of the Mayflies and Other Nature Stories

By Mabel Crawford Merritt. 1973. Exposition Press, Inc., New York, 11753. 63 pp. $3.50 U.S.

From the front dust cover: "An unusual look at the miniature in nature by a loving, lifetime observer of the New England scene." But the stories are told about situations from New England, the Appalachians, and the Fiji Islands.

There are 11 chapters, but it will suffice to list only a few: Dance of the Mayflies; Just Whirligigging; Fidgeting on Fiji; Bird Friends; and Up Through the Mandrakes. The author uses the literary device of the removed, objective third person, and at other times assumes the role of the second person. The blending is confusing, and the reader is left with the impression that perhaps the author identifies with Mother Nature.

Some of the stories are anthropocentric. For example (p. 48), she attributed the singing of the wood thrush to "He remembered how good I had been to his babies the summer before, and he was trying to repay me in the best way he knew how, by treating me to a symphony of flutelike music for a whole month!" Other stories are anthropomorphic. For example (p. 36), she wrote that the reason the hermit crabs were exchanging shells was ". . . that the clothes they were wearing were too plain looking, too worn-out and drab; they wanted some nice new ones, shiny ones, gay-colored ones." The real reason that they change shells is that they have outgrown the old shell and are looking for a larger one.

The author's purpose in writing the book was ". . . to record all these meticulous observations so that young people might open their eyes to the wonders of nature . . . ." I loaned the book to an eight-year-old boy

who is keen on the outdoors, however, and I have read the book to my own children, aged 6 and 4, but none of them was particularly "turned on" by the stories.

I suspect that youngsters about 11 to 12 years of age would be the best audience, as this is the age group the author knows best. Several adults who read the book found it difficult to start, but "rather enjoyed it" overall. It might also be thoroughly enjoyed by older adults. I judge it to be most difficult to write a book for a particular age group—to know where to separate generalities and details, and where to fill in with imagination. It is far easier to write a technical book for a technical audience.

The book is bound in what I feel is an unnecessarily heavy gray-blue buckram. The print is large, and there is a lot of bare page wasted at the end of each chapter. The illustrations are larger than necessary, fuzzy, and sometimes far from accurate. I do not recommend the book for everyone.

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NEW TITLES

Zoology

Abbott, R. T. (*Editor.*) 1973. **American Malacologists.** Biographies of 1500 malacologists. American Malacologists, 6314 Waterway Drive, Falls Church, Va. 22044. 496 pp. $12.50.

Ali, S. and S. D. Ripley. c1973. **Handbook of the Birds of India and Pakistan.** Together with those of Bangladesh, Nepal, Sikkim, Bhutan and Sri Lanka. Vol. 8, Warblers to Redstarts. Oxford University Press, New York. 278 pp. $16.50.

Anonymous. 1973. **Fishes of the Western North Atlantic.** Part 6, Order Heteromi (Notacanthiformes), Suborder Cyprinodontoidei, Order Berycomorphi (Beryciformes), Order Xenoberyces (Stephanoberyciformes), Order Anacanthini (Gadiformes), in part Macrouridae. Sears Foundation for Marine Research, New Haven, Conn. Memoir No. 1. 698 pp. $27.50.

Brown, J. H. 1973. **Toxicology and Pharmacology of Venoms from Poisonous Snakes.** Thomas, Springfield, Ill. 184 pp. Cloth $13.75; paper $9.95.

Chapskii, K. K. and V. E. Sokolov (*Editors.*) 1973. **Seals, Dolphins, Porpoises.** Translated from two Russian works, 1971. Halsted (Wiley), New York, and Israel Program for Scientific Translations, Jerusalem. 232 pp. $24.

★*Crossman, E. J. and G. E. Lewis. 1973. **An Annotated Bibliography of the Chain Pickerel, *Esox niger* (Osteichthyes: Salmoniformes).** Royal Ontario Museum, Life Sciences Miscellaneous Publication. 81 pp. $2.50.

★Clarke, A. H. 1973. **The Freshwater Molluscs of the Canadian Interior Basin.** Institute of Malacology, University of Michigan, Ann Arbor. 510 pp. Paper $25.

Cushing, D. 1973. **The Detection of Fish.** Pergamon, New York. 200 pp. $16.50.

*ffrench, R. 1973. **A Guide to the Birds of Trinidad and Tobago.** Livingston Publishing Co., Wynnewood, Pa. 512 pp. $12.50.

*Grzimek, B. (*Editor.*) 1973. **Grzimek's Animal Life Encyclopedia.** Van Nostrand Reinhold, New York. 13 volumes of about 600 pp. each. $25.00 each.

★*Hart, J. L. 1973. **Pacific Fishes of Canada.** Fisheries Research Board of Canada, Bulletin 180. 740 pp. $8.

Henderson, G. N. and D. J. Coffey. (*Editors.*) 1973. **The International Encyclopedia of Cats.** McGraw-Hill, New York. 256 pp. $17.95.

*Klaits, J. and B. (*Editors.*) 1974. **Animals and Man in Historical Perspective.** Harper and Row, New York. 169 pp. Paper $2.95.

Lanham, U. 1973. **The Bone Hunters.** Columbia University Press, New York. 286 pp. $12.95.

Laycock, G. 1973. **Autumn of the Eagle.** Scribner, New York. 240 pp. $6.95.

Peterson, R. T. and E. L. Chalif. 1973. **A Field Guide to Mexican Birds.** Field Marks of all Species found in Mexico, Guatemala, Belize (British Honduras), El Salvador. Houghton Mifflin, Boston. Peterson Field Guide Series No. 20. 298 pp. $8.95.

Rockstein, M. (*Editor.*) 1973. **The Physiology of Insecta.** Vol 1. Academic Press, New York. 2nd ed. 512 pp. $38.

Rudnai, J. 1973. **The Social Life of the Lion.** A Study of the Behaviour of Wild Lions (*Panthera leo massaica* [Newmann]) in the Nairobi National Park, Kenya. Washington Square East, Publishers, Wallingford, Pa. 122 pp. $14.50.

Schaller, G. B. 1973. **Golden Shadows, Flying Hooves.** Knopf, New York. 290 pp. $8.95.

★*Scott, W. B. and E. J. Crossman. 1973. **Freshwater Fishes of Canada.** Fisheries Research Board of Canada, Bulletin 184. xi + 966 pp. $9.75.

Spradbery, J. P. 1973. **Wasps.** An Account of the Biology and Natural History of Solitary and Social Wasps. University of Washington Press, Seattle. 408 pp. $17.50.

★*Stirrett, G. M. 1973. **The [Summer, Autumn, Winter, Spring] Birds of Point Pelee National Park.** Information Canada, Ottawa. 4 booklets of 28 to 36 pages each. $0.50 each.

Young, P. T. 1973. **Emotion in Man and Animals.** Its Nature and Dynamic Basis. Krieger, Huntington, N.Y. 2nd ed. 480 pp. $14.95.

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★*Bassett, I. J. 1973. **The Plantains of Canada.** Canada Department of Agriculture, Research Branch, Monograph No. 7, 47 pp.

★Clarke, L. J. 1973. **Wild Flowers of British Columbia.** Gray's Publishing Co., Sidney, Vancouver Island, B.C. 591 pp. $24.95.

*Crum, H. 1973. **Mosses of the Great Lakes Forest.** University of Michigan Herbarium Contribution Vol. 10. 404 pp. $6.00.

Franklin, J. F. and C. T. Dyrness. 1973. **Natural Vegetation of Oregon and Washington.** U.S. Forest Service, Portland, Oregon. USDA Forest Service General Technical Report PNW-8. 418 pp. Paper $4.65.

Hitchcock, L. and A. Cronquist. 1973. **Flora of the Pacific Northwest.** An Illustrated Manual. University of Washington Press, Seattle. 730 pp. $25.

*Jalas, J. and J. Suominen. (*Editors.*) 1972, 1973. **Atlas Florae Europaeae.** Distribution of Vascular Plants in Europe. 1, Pteridophyta (Psilotaceae to Azollaceae). 121 pp. $10. 2, Gymnospermae (Pinaceae to Ephedraceae). 40 pp. Academic Bookstore, Keskuskatu 1, SF-00100, Helsinki 10, Finland.

Korling, T. 1973. **Wild Plants in Flower II. The Boreal Forest and Borders.** With notes on the species and their distribution by E. G. Voss. Dundee, Illinois. 72 pp. $2.00.

*Mohlenbrock, R. H. and J. W. Voigt. 1974. **A Flora of Southern Illinois.** Southern Illinois University Press, Box 3697, Carbondale, Illinois. 400 pp. Paper $3.95.

★Robertson, A. W. and F. C. Pollett. 1973. **Checklist of the Genus *Carex* in Newfoundland.** Newfoundland Forest Research Centre, St. John's, Newfoundland. Forestry Service, Environment Canada.

★*Savile, D. B. O. 1973. **Collection and Care of Botanical Specimens.** Reprinted with addenda. Publishing Division, Information Canada, Ottawa. 128 pp. $2.50.

★*Szczawinski, A. F. and A. S. Harrison. 1973. **Flora of the Saanich Peninsula.** Occasional Paper No. 16, Provincial Museum of British Columbia. 114 pp. $1.

Environment

★*Anonymous. 1973. **Bedford Institute of Oceanography.** Biennial Review 1971-1972. Dartmouth, Nova Scotia. 366 pp.

Anonymous. 1972. **Environment and Cancer.** Proceedings of a Symposium, Houston, March 1971. Williams and Wilkins, Baltimore. 476 pp. $19.

Anonymous. 1973. **Weather and Climate Modification.** Problems and Progress. Committee on Atmospheric Sciences, National Research Council. National Academy of Sciences, Washington, D.C. 258 pp. Paper $6.25.

Bayly, I. A. E. and W. D. Williams. 1973. **Inland Waters and their Ecology.** Longman, Camberwell, Australia. (U.S. distributor, Entomological Reprint Specialists, Los Angeles). 316 pp. $22.50.

Bond, R. G., C. P. Straub, and R. Prober. (*Editors.*) 1973. **Handbook of Environmental Control.** CRC Press, Cleveland, Ohio. Vol. 1, Air Pollution, 576 pp., $36. Vol. 2, Solid Waste, 580 pp., $31.

Coates, D. R. (*Editor.*) 1973. **Environmental Geomorphology and Landscape Conservation.** Vol. 3. Dowden, Hutchinson and Ross, Stroudsburg, Pa. 484 pp. $23.

★*Corbet, P. S. 1972. **The Microclimate of Arctic Plants and Animals, on Land and in Fresh Water.** Acta Arctica Fasc. 18. Copenhagen, Munksgaard. 44 pp.

Coulston, F. and F. Korte. (*Editors.*) 1973. **Environmental Quality and Safety.** Global Aspects of Chemistry, Toxicology and Technology as Applied to the Environment. Vol 2. Thieme, Stuttgart, and Academic Press, New York. 336 pp. $24.

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★*Estrin, D. and J. Swaigen. (*Editors.*) 1974. **Environment on Trial.** A Citizen's Guide to Ontario Environmental Law. New Press, Toronto. 400 pp. $2.95. The first Canadian book about environmental rights and resources.

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Kirk, R. 1973. **Desert.** The American Southwest. Houghton Mifflin, Boston. 362 pp. $10.

Micklin, M. 1973. **Population, Environment, and Social Organization.** Current Issues in Human Ecology. Dryden Press, Hinsdale, Ill. 510 pp. Paper $5.95.

Nicholson, M. 1973. **The Big Change.** After the Environmental Revolution. McGraw-Hill, New York. 288 pp. $8.95.

Ott, J. N. 1973. **Health and Light.** The Effects of Natural and Artificial Light on Man and Other Living Things. Devin-Adair, Old Greenwich, Conn. 208 pp. $7.95.

*Perry, R. 1973. **The Polar Worlds.** Taplinger Publishing Co., New York. 316 pp. $8.95.

★*Roberts-Pichette, P. 1972. **Annotated Bibliography of Permafrost-Vegetation-Wildlife-Landform Relationships.** Information Report, Forest Management Institution, Environment Canada, Ottawa. 350 pp.

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Seale, R. L. and R. A. Sierka. (*Editors.*) 1973. **Energy Needs and the Environment.** Proceedings of a Symposium, Tucson, Arizona, 1971. University of Arizona Press, Tucson. 350 pp. $9.50.

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Trzyna, T. C., E. V. Coan, P. Rambach, and C. Weiss. (*Editors.*) 1973. **World Directory of Environmental Organizations.** Sierra Club, San Francisco, California, in association with the Center for California Public Affairs, Claremont, Calif. 156 pp. Paper $7.50.

Utton, A. E. (*Editor.*) 1973. **Pollution and International Boundaries.** United States-Mexican Environmental Problems. University of New Mexico Press, Albuquerque, N. Kimball. W. C. Estler, ed. Midwest Research Institute, Kansas City, Mo. 148 pp. Paper $5.

★*Warden, G. and E. Mankelow. c1973. **Wild Rivers.** A Proposal for Wild, Scenic and Recreation Rivers in British Columbia. British Columbia Wildlife Federation No. 6, 17655 57th Avenue, Cloverdale, B.C.

★*Zoltai, S. C. and W. W. Pettapiece. 1973. **Studies of Vegetation, Landform and Permafrost in the Mackenzie Valley.** Terrain, Vegetation and Permafrost Relationships in the Northern Part of the Mackenzie Valley and Northern Yukon. Environmental-Social Committee Northern Pipelines, Task Force on Northern Oil Development Report No. 73-4. Information Canada. 105 pp. $2.

Miscellaneous

Anonymous. c1973. **Water Policies for the Future.** Report of the National Water Commission. Water Information Center, Port Washington, New York. 580 pp. Hard cover $17.50.

Benjamin, B., P. R. Cox, and J. Peel, (*Editors.*) 1973. **Resources and Population.** Proceedings of a Symposium, London, 1972. Academic Press, New York. 182 pp. $7.95.

Butler, J. N., B. F. Morris, and J. Sass. 1973. **Pelagic Tar from Bermuda and the Sargasso Sea.** Bermuda Biological Station for Research, St. George's West, Bermuda. 346 pp. Paper $5.

Callahan, D. 1973. **The Tyranny of Survival.** And Other Pathologies of Civilized Life. Macmillan, New York. 284 pp. $6.95.

Gait, R. I. 1973. **Exploring Minerals and Crystals.** McGraw-Hill, New York. 120 pp. $7.95.

Hellman, H. 1973. **Energy in the World of the Future.** Evans, New York. 240 pp. $5.95.

*Keith, S. 1973. **One Man's Wilderness.** From the Journals and Photograph Collection of Richard Proenneke. Alaska Northwest Publishing Co., Anchorage, Alaska. 75 pp. $7.95.

Kelsey, R. J. 1973. **Walking in the Wild.** The Complete Guide to Hiking and Backpacking. Funk and Wagnalls, New York. 362 pp. $6.95.

★*Legget, R. F. 1973. **Cities and Geology.** McGraw-Hill, New York. 624 pp. $15.50.

★*Nelson, J. G. 1973. **The Last Refuge.** Harvest House, Montreal. 230 pp. $7.50.

★*Pelletier, W. and T. Poole. **No Foreign Land.** The Biography of a North American Indian. Random House, Toronto. 212 pp. $7.95.

Pitcher, M. G. (*Editor.*) 1973. **Arctic Geology.** Proceedings of a Symposium, San Francisco, Feb. 1971. American Association of Petroleum Geologists, Tulsa, Okla. 746 pp. $30.

Rudwick, M. J. S. 1973. **The Meaning of Fossils.** Episodes in the History of Palaeontology. Macdonald, London, and Elsevier, New York. 288 pp. $18.50.

Stellman, J. M. and S. M. Daum. 1973. **Work is Dangerous to your Health.** A Handbook of Health Hazards in the Workplace and What You Can Do about Them. Vintage, New York. 450 pp. Paper $1.95.

Weidner, C. H. 1974. **Water for a City.** A History of New York City's Problem from the Beginning to the Delaware River System. Rutgers University Press, New Brunswick, N.J. 340 pp. $17.50.

★Written by a Canadian and/or about Canada.

*Assigned for review.

Note—If any person is willing and qualified to review a book that would be of interest to readers of The Canadian Field-Naturalist, please contact the Book Review Editor so she can request a review copy from the publisher.

Report of Council to the Ninety-Fifth Annual Meeting of The Ottawa Field-Naturalists' Club, 21 January 1974

Report of the Publications Committee

The Committee met about seven times during the year to consider a variety of problems, particularly the degree of independence that *The Canadian Field-Naturalist* should have from the Club, assessment of publication costs to authors, general policy regarding content of the journal, and revisions of current procedures to improve processing of manuscripts.

Since the last Annual Meeting *The Canadian Field-Naturalist* has published four numbers. These include Volume 86, Number 4 (October–December 1972, containing 109 pages); and Volume 87, Numbers 1, 2, and 3, containing 106, 103, and 131 pages, respectively. Volume 87, Number 4 should be mailed early in January 1974.

During 1973, 153 manuscripts were submitted to *The Canadian Field-Naturalist*; this number is approximately twice the number received in 1970. Consequently the time spent by the Editor in processing manuscripts has increased. While the number of submissions reflects an increasing interest in *The Canadian Field-Naturalist,* it has magnified several perennial problems. In particular, it takes excessive time for some referees to review and return manuscripts to the Editor, thus delaying their publication.

The Grants and Scholarships Committee of the National Research Council awarded *The Canadian Field-Naturalist* a grant of $3000 and the Conservation Committee of The Canadian National Sportsmen's Show again generously supported the publication of *The Canadian Field-Naturalist* through a grant of $750. These grants enabled *The Canadian Field-Naturalist* to expand the number of pages in the journal and to extend continued support to authors who do not have a source of funds to cover page charges, etc. The Publications Committee has continued to support changes in the accounting system which will clearly separate the costs of publications from those of the Club. The success of these efforts can be seen in the financial statement of the Club.

J. Ginns
Chairman

Report of the Excursions and Lectures Committee

During 1973 there were 50 excursions, five lectures, one discussion meeting, one film evening, one general meeting and the Annual Dinner. The excursions consisted of 21 relating to ornithology, three to botany, two to entomology, one to botany and entomology, one to mineralogy, one to herpetology, one to astronomy, 19 of general interest, and one to conservation (in cooperation with the Natural Areas Committee). The topics for the lectures were mosses and lichens, bats, butterflies, orchids, and fishes. Although the total number of excursions was the same as that in 1972, there was a change to more excursions of general interest (increased from 9 to 19) at the expense of ornithological excursions (decreased from 30 to 21).

The subject for the general meeting was "The Role of the OFNC in Local Conservation." The discussion was concerned mainly with the recent development of the Graham's Bay area, the possible establishment of a waterfowl reserve east of the Ottawa Beach Motel, and whether the club should approach the National Capital Commission requesting the construction of observation facilities at Ramsayville Marsh. The discussion was most useful, and the apparent success of this meeting indicates that meetings of this type should be held more frequently.

The Annual Dinner was held at the Eastview Hotel. The after-dinner talk on "The Great Gray Owl" was given by Dalton Muir of the Canadian Wildlife Service. The talk was illustrated by a film of Great Gray Owls at the nest, taken by Dalton Muir and Robert Taylor.

The committee thanks sincerely all the speakers, leaders, and members that helped with refreshments.

Roger A. Foxall
Chairman

Report of the Finance Committee

The Finance Committee has a most important function at the beginning of each Club year, as it has been made responsible for the production of a detailed budget, allocating expenditure over the forthcoming year to the Committees and to the various objectives of the Club, including the grant to *The Canadian Field-Naturalist.*

For the purpose of preparing the budget, a lengthy meeting was held on the afternoon and evening of Monday, January 19 at the University Club of Ottawa. The budget produced on this occasion was presented to Council at the meeting on February 19, but was accepted only in part. Further deliberations respecting the budget involved the members of the Committee as individuals, but were not the subject of a further formal meeting.

The Chairman of the Committee assumed the responsibility of contacting the Department of National Revenue respecting the status of a Charitable Institution for the Club. This would enable the provision of receipts to persons making donations to the Club, which would be recognized as an income tax deduction.

At a meeting of the Committee on November 19, two important matters were discussed. It was agreed that the Club would seek the status of a Charitable Corporation, involving a requirement to maintain certain records, to provide suitable receipts to donors and to make annual returns to the tax authorities. It was also agreed that the financial records of the Club should be altered, commencing with the 1974 fiscal year, to separate all transactions relating to the operation of *The Canadian Field-Naturalist* from those of the Club itself. For this purpose it was recommended that a separate bank account be established for *The Canadian Field-Naturalist*.

During the current year the Committee has taken no action respecting the Investment Fund comprising an investment of $10,700 in Canada Savings Bonds (which will almost double in value from compound interest if held to maturity), 35 common shares in Bell Telephone Co., two preferred shares and two shares of Microsystems International. It is here recorded that, should a complete separation of finances of the Club and *The Canadian Field-Naturalist* take place in the future, a decision will have to be made regarding the portion of these funds which is properly payable to the Journal as representing the proceeds of funds earned by the Journal from subscriptions and other sources.

GEOFFREY WASTENEYS
Chairman

Report of the Membership Committee

The returns from two types of questionnaires were analyzed and reported to the Council. The 53% response received from a question sent with the 1973 membership renewal form to local members has given the Council a good idea of the occupational interests of its local members. Returns from questions on the back of the Application for Membership are informing us about the aspects of the Club which attract new members and about those people who have time to contribute to the affairs of the Club.

Memberships	1972	1973	Change
Local, individual	404	329	−75
Local, family	208	217	+ 9
Canada, individual	465	481	+16
Canada, family	0	10	+10
U.S.A., individual	106	130	+24
U.S.A., family	0	1	+ 1
Other countries	13	6	− 7
Honorary	14	13	− 1
Total Memberships	1210	1187	−23

The total membership has decreased slightly this year. We regret the loss of Professor A. F. Coventry, an honorary member since 1971 and a member since 1913.

JOYCE REDDOCH
Chairman

Report of the Research and Briefs Committee

A trial survey for an inventory of natural areas was made by sending requests for information on Gloucester Township and the Carp Hills to a limited number of members. Some useful information was obtained. A survey of all local members, through *Trail & Landscape*, regarding the entire Ottawa area is now in progress.

A letter was sent to the Mayor of Ottawa opposing the proposed chlorination of Mooney's Bay. Later, a technical meeting on the subject was attended with the City Commissioner of the Environment, provincial officials, and Pollution Probe. As a result, detailed technical information in support of our position was submitted in writing.

A general statement on the topic of "Wetlands, Conservation and Public Safety" was sent to Gloucester Township in support of the enlightened stand of the Director of Planning.

In collaboration with the Bird Record Committee, a detailed proposal for a waterfowl reserve at Ottawa Beach was sent to Nepean Township.

In collaboration with the Natural Areas Committee, information on the Carp Hills, based in part on the above survey, was sent to the Ottawa-Carleton Planning Board in response to their request.

A letter was sent to Action Britannia at their request, opposing any road or bridge construction which would damage Britannia Woods or Pond.

A letter was sent to the Ontario Minister of Natural Resources urging approval of the Ottawa-Carleton bylaw respecting tree-cutting. This was prompted by examples of indiscriminant clearing of woodlots for firewood.

Work is progressing on a detailed submission to the Ottawa-Carleton Regional Planning Board suggesting modifications to their draft Regional Plan. The natural areas designated in the present draft plan include most of the territory in the 19 areas proposed by the Club in 1970. The members of the Natural Areas Committee of that year are to be congratulated for their initiative and thoroughness in making these proposals.

Our work this year has been greatly aided by the cooperation of the above-mentioned committees, individual Club members, and Gloucester Pollution Probe.

While the Ottawa-Carleton Regional Plan is a reasonable, although imperfect, document from the conservationists' point of view, the Club can not relax its conservation activities in the foreseeable future. First, there may be several hurdles to clear before the plan becomes legally binding. Second, townships and cities within the Region will then have to come into conformity with the plans. Moreover, local, as opposed to regional, problems may not be covered by the plan. Finally, outside the Region, especially on the Quebec side, there seems to be very little long-range planning. Obviously the Club must devote great effort to keep informed and vigilant to meet the challanges ahead.

Those wishing to see a copy of any of the above submissions may obtain a copy by writing to the Chairman, Research and Briefs Committee.

A. H. REDDOCH
Chairman

Report of the Natural Areas Committee

In 1973, field work was undertaken to provide the Ottawa-Carleton Regional Municipality with natural history information on the Carp Hills. The study area is identified in the Regional Master Plan as the South Marsh Highlands. The results were submitted to the Regional planning staff in November 1973.

The Research and Briefs, and Natural Areas Committees cooperated closely during the year, and the results indicate that one committee could replace the two without any loss of effectiveness.

H. MACKENZIE
Chairman

Report of the Macoun Field Club Committee

The twenty-fifth anniversary of the founding of the Macoun Field Club was celebrated at the closing meeting of the 1972–1973 session on June 9. To help celebrate this silver anniversary, Bill Baldwin, one of the co-founders of the Club, provided the audience with an account of the founding of the Club and some interesting reminiscences of those early years. To further celebrate this first quarter-century, an outstanding edition of *The Little Bear*, bound between "silver" covers, was produced by the members. Its 102 numbered pages and one additional plate of photos surpasses all previous issues in content and style of presentation.

The Club, still housed at 860 Bank Street, had shown somewhat of a decline in its membership. By May there were approximately 27 Seniors, 20 Intermediates, and 17 Juniors. Perhaps the location and somewhat cramped quarters may have contributed towards the decline in membership, but the eagerness and generally wholehearted participation of its devout members made possible the completion of a very successful year.

Irwin Brodo continued in his advisory capacity to the Seniors. Through the perseverence and the hard work of the senior members, the Macoun Nature Trail at the Club Study Area in Bells Corners reached completion in the fall of 1973. A trail-guide booklet was prepared by the members to be used on trail walks.

A considerable number of invited speakers addressed the Seniors on diverse topics such as Polar Bear Research, Landslides in Eastern Canada, Feeding and Territorial Behavior of Wolves, and Plant Survival in Peat Bogs. Various other presentations were given, some by the members themselves, including a symposium on the subject of Field Studies in the Ottawa Area. A successful canoe trip to Algonquin Park between August 26 and September 4 was the highlight of the field season for those who were able to participate.

The recipient of the Ottawa Field-Naturalists' scholarship to the Red Bay Camp (this year named the "W.K.W. Baldwin F.O.N. Scholarship") was Jonathan Field.

The supervision of the Junior and Intermediate groups changed hands on February 3. Mr. Alex Fournier, busy with numerous other duties, relinquished the chairmanship to Dr. Erich Haber, a new staff member with the Botany Division of the National Museum of Natural Sciences. Joining Dr. Haber as assistant chairman was Len Marhue of the Museum's Zoology Division. Jim Johnston, also with the Zoology Division, has served as a volunteer with the Juniors and Intermediates.

With the reorganization of the Clubroom and the initiation of project sessions and the active participation of the younger members, the Junior and Intermediate programs took on a revitalized atmosphere.

Two field trips were made in the spring by the Juniors and Intermediates. The first was a nature walk around the southern end of Constance Lake with our guest leader Ridgeley Williams, who assisted with rock identifications; and the second, a full day's outing to Mary Stuart's property. Two morning trips were also held in the fall, both to the Rideau River: to Billings Bridge with the Intermediates, and with both groups to Vincent Massey Park opposite Carleton University.

The Seniors continued their visits to the Bell's Corners Study Area on every possible weekend. The results of their work have been passed on to the National Capital Commission and the Ontario Ministry of Natural Resources.

Donations to the Club were unusually high this past year. These extra funds were used to help finance the completion of the nature trail and to purchase some of the books for the library. Through the efforts of the Seniors, the library was reorganized, with the main improvements

being the new accessioning system and the addition of $175-worth of new books.

Expansion of the Club's membership and of its program to former levels should be possible as the renovation of the Victoria Museum Building progresses and the Club returns, hopefully in the near future, to new and larger facilities in its old headquarters at Metcalfe and McLeod.

ERICH HABER
Chairman

Report of the Education Committee

In 1973 for the first time, the Ottawa Field-Naturalists' Club, at the suggestion of the Education Committee, offered three Science Fair prizes in environmental biology. These prizes were proposed to encourage entries in this field, and prizes were awarded to exhibits in two of three categories. We recommend that the prizes be offered again for the 1974 Science Fair.

From February through May 1973 two members of the Committee attended several meetings of a Community Interest Group on environmental education under the Man and Resources program. A comprehensive report was written, making suggestions for increased environmental education both within and outside the formal education system. The Education Committee chairman was subsequently a delegate at the Man and Resources conference in November 1973.

A number of requests for speakers was received by the Committee. Because many of these involved organizations working with children and young adults, the Committee contacted the Macoun Club for assistance. Several senior members of the Club gave talks or led nature walks in response to these requests. A request from a girl-guide camp to assist in laying out and interpreting a nature trail will be followed up in the spring.

The committee has identified useful roles it could fill in the near future to promote environmental education, and requires additional members able to work on one or more projects.

AILEEN MERRIAM
Chairman

Report of the Bird Records Committee

Since the previous report of December 1972, the Bird Records Committee has organized two Christmas counts, one spring count, and one fall count.

On the Christmas count of 17 December 1972, 82 observers (a new high) managed to find a total of 69 species, even though the weather conditions were particularly severe. The outstanding features of the count were the observations of three very rare predators, a Gyrfalcon, a Peregrine Falcon, and a Bald Eagle. Other noteworthy species were Pied-billed Grebe, Canada Goose, Lesser Scaup, Barrow's Goldeneye, Mockingbird, and Brown Thrasher.

The spring count held on 20 May 1973 was also very successful. The 190 species found by 40 observers was the largest number of species seen in Ottawa in one day. Naturally there were many outstanding birds in such a large list. Those new to the cumulative spring count total were Red-necked Grebe, White-winged Scoter, Rough-legged Hawk, Black-backed Three-toed Woodpecker, Gray Jay, Boreal Chickadee, Blue-winged Warbler (the first observation of this species in Ottawa), Western Meadowlark, and Lapland Longspur.

The fall count of 2 September 1973 will be remembered as the hottest ever held—a blistering 91° in the afternoon. Thirty-five sweating observers identified 180 species including a Cormorant, 8 Gadwalls, 12 Redheads, 3 Turkey Vultures, 10 Black-crowned Night Herons, and a Pigeon Hawk.

The 1973 Christmas count was held on December 16. Seventy-five observers found 79 species (a new high). Undoubtedly the bird of the day was a Boreal Owl, but other interesting species were Thayer's Gull, Long-eared Owl, Bald Eagle, Belted Kingfisher, Horned Grebe, Red-necked Grebe, Wood Duck, Canvasback, Barrow's Goldeneye, Mockingbird, and Rufous-sided Towhee.

Forty-four records of unusual birds were considered by the committee, of which 37 were accepted. Those accepted as additions to the Ottawa district bird list were Harris' Sparrow, Great Egret, Arctic Tern, Little Blue Heron, Connecticut Warbler, and Pomarine Jaeger. Details of these records will be published in *Trail & Landscape*.

ROGER FOXALL
Chairman

Report of the *Trail & Landscape* Editorial Committee

As in previous years, five issues of *Trail & Landscape* were published in 1973. Among the items making up the 140 pages were articles and notes on local natural history, bird and plant records of note in our area, conservation news and views, photos, drawings, poems, and letters. Advice for beginning naturalists about books and photographic techniques was included. *Trail & Landscape* has presented reports of OFNC Council action and other club business, and summaries of Federation of Ontario Naturalist news.

A steady trickle of contributions, from within and outside the Club, assures continuance of publication. The editorial staff, however, find themselves underwhelmed by the amount of club-member participation, and periodically reduced to using what they feel is too much of their

own work. There is a particular need for more black-and-white photos and line drawings.

ANNE HANES
Editor, *Trail & Landscape*

Report of the Publicity Committee

The Publicity Committee reports that it does not have exact terms of reference. It is recommended by the outgoing Committee that this should be established by the Council.

In illustration of the foregoing, the present Committee has considered that its function was to provide for publicity for Club activities when requested to do so, either by the Council or by one of the other Committees. This would take the form of a press release or arrangements for the presence of Press representatives. During the current year there has been no occasion for this action, but it is anticipated that it may be required on the occasion of the Annual Meeting in January. The Committee has naturally hesitated to initiate publicity in areas where the Committees themselves had already established contact with the media.

GEOFFREY WASTENEYS
Chairman

Report of the Federation of Ontario Naturalists Committee

Contact was maintained over the year with the Federation of Ontario Naturalists executive and head office on proposed projects, activities, briefs to governmental and institutional bodies, and resolutions passed at Annual Meeting. This information was conveyed to our members by means of one-page reports in each of the five issues of *Trail & Landscape*.

VI HUMPHREYS
Chairman

Report of the Bird Feeders Committee

The two feeding stations managed by the Club have been in operation since October: the west-end feeder on Moodie Drive on Ontario Ministry of Natural Resources property, under the care of Hugh and Hazel Munro, and the east-end one on Davidson Road on National Capital Commission territory, under George McGee and Bill Holland. One committee meeting was held, at which plans were discussed for possible feeders in other areas of the city, for hospitals, and for senior citizen residences, provided adequate maintainence of these stations can be furnished by those institutions.

An article on bird feeders appeared in issue No. 5 of *Trail & Landscape*. Information and leaflets on bird feeders were forwarded to the Metropolitan Structures of Canada Ltd., Montreal, at the request of their Public Relations Officer, with regard to a new residential project on Nuns' Island.

VI HUMPHREYS
Chairman

Minutes of the Ninety-Fourth Annual Meeting of The Ottawa Field-Naturalists' Club

The 94th annual meeting of The Ottawa Field-Naturalists' Club was held in the auditorium of the National Research Council on Sussex Drive on Tuesday, December 12, 1972. The meeting was called to order at 8:15 p.m. by the President, Mrs. Sheila Thomson. Forty-five persons were present.

The Secretary read the minutes of the 93rd annual meeting and moved that they be adopted. Dr. Foxall seconded the motion and it carried.

Dr. Erskine announced that he did not have a statement of financial standing prepared as the books had not been balanced. He promised to have a statement available for the next issue of *The Canadian Field-Naturalist*.

Dr. Joyce Reddoch announced that at the last meeting of Council the following five persons had been elected honorary members:

Dr. W. G. Dore
Dr. J. Dewey Soper
Dr. Loris S. Russell
Dr. Robie W. Tufts
Dr. W. Austin Squires

The President reviewed the annual report, a copy of which was distributed to those present. Among the highlights mentioned were the appointment of the new editor of *The Canadian Field-Naturalist,* Dr. Lorraine Smith; the $3,000 grant from the National Research Council to help publish *The Canadian Field-Naturalist;* the 60 activities arranged by the Excursions and Lectures Committee; the widespread appeal of *Trail & Landscape*; the activities of the Macoun Field Club, including 20 speakers; the budget prepared by the Finance Committee; the increased workload assumed by the Membership Committee; the three bird counts of the Bird Records Committee.

With the correction of a few minor points mentioned during the meeting, the Secretary moved that the annual report be accepted. Vi Humphreys seconded the motion and it carried.

The President drew attention to some additional highlights which were not mentioned in the annual report. These included the sponsorship of a Macoun Club member to the F.O.N. Camp at Red Bay; the $100 donation to the Ottawa-Hull Chapter of the National and Provincial Parks Association; the sponsorship of the

Ottawa-Hull Chapter of National and Provincial Parks Association in its quest for a $2,000 White Owl Conservation Award, which was successful; and recommendations to the Regional Municipality of Ottawa-Carleton about the route of Highway 416.

The President paid tribute to the Business Manager, Mr. W. J. Cody; the retiring editor of *The Canadian Field-Naturalist*, Dr. Theodore Mosquin, and the retiring secretary, Mr. Alexander W. Rathwell; two retiring members of Council, Miss Mary Stuart and Mr. George H. McGee; and to Miss Elizabeth Burrell for her efforts in arranging for the serving of refreshments on several occasions.

The President then called on Dr. Todd to review the main proposed amendments to the constitution. He drew attention particularly to Article 9 and the loss of the office of the second vice-president, but the gain of the office of a corresponding secretary; Article 10 and the reduction in the size of Council; Article 11 and the standing committees; Article 13 and the change in date of the annual meeting to January; Article 19 and the duties of the recording secretary; and Article 20 and the duties of the corresponding secretary.

Dr. D. A. Smith asked why the Presidents of Affiliated Societies were included on Council. Dr. Todd replied that it was more or less as a courtesy. Dr. Smith also wondered why the editor of *The Canadian Field-Naturalist* was included when formerly that person was an *ex officio* member. Dr. Todd replied that the Council which had drafted the revised constitution considered that the editor should be included.

In order to avoid prolonged discussion of the revised constitution Dr. Brodo moved that the amendments as presented by Dr. Todd either be accepted or rejected but not amended at the meeting. The motion was seconded by Mr. W. Grimm. Nineteen voted for this proposal, and 13 against. It was then moved by Dr. Todd, seconded by Dr. Mosquin, that the constitution as presented be accepted. Forty-one voted for this proposal and one against; therefore, it carried.

The President then called on Dr. Foxall to present for election the slate of officers and council. Dr. Foxall read out the slate and moved that it be adopted. Mr. Wasteneys seconded the motion and it carried.

Mrs. Thomson called for the appointment of auditors for 1973. It was moved by Dr. Foxall, seconded by Arnet Sheppard that Monty Brigham and Harry Williamson be so appointed. Carried.

Mrs. Thomson then introduced the new president, Dr. Brodo. Dr. Brodo thanked Mrs. Thomson and paid tribute to her leadership. He said he hoped that those appointed as committee chairmen would carry out their duties and that the general membership would support them.

At the conclusion of the business meeting, Dr. Fred Roots of the Polar Continental Shelf Project of the Department of Energy, Mines and Resources showed some of his colored slides illustrating the various types of landscapes in northern Canada, including the arctic islands, and gave some very informative comments about the various areas. The meeting adjourned about 11:15 p.m., before which refreshments were served.

A. W. RATHWELL
Secretary

Proposed Amendments to the Constitution of THE OTTAWA FIELD-NATURALISTS' CLUB

Pursuant to Article 24 (AMENDMENTS) of the revised Constitution adopted at the 94th Annual Business Meeting on 12 December 1972 (see The Canadian Field-Naturalist 86(3): 327-330. 1972), on 2 January 1974 I gave notice in writing to the (Recording) Secretary of eight proposed amendments to the Constitution to be presented to the club at the 95th Annual Business Meeting on 21 January 1974 and voted upon at the 96th Annual Business Meeting in January 1975.

Accordingly on 21 January 1974 I made the following motions:

Motion 1: that the text of Article 24 of the existing constitution be deleted and the following text substituted:

"Each proposed amendment to this constitution shall deal with only one article, and shall be moved by one member and seconded by another. Written notices of such motions shall be sent to the Recording Secretary prior to June 1 so that they may be published in The Canadian Field-Naturalist at least one month before they are to be presented at the Annual Business Meeting the following January. At

this meeting, each motion for amendment shall be moved, seconded and discussed separately; each amending motion may itself be amended and carried by a two-thirds majority of the members present."
Seconded by S. Thomson.

Motion 2: that Article 5 be deleted entirely.
Seconded by R. Foxall.

Motion 3A: that the first paragraph of Article 10 be deleted and replaced by the following:
"The Council shall consist of the officers of the club and up to eighteen additional members. In addition, the retiring President shall continue as a member of the Council for the club year following his retirement."
Seconded by G. Neville.
In the event that Motion 3A is defeated, the following is substituted:

Motion 3B: that the first paragraph of Article 10 be deleted and replaced by the following:
"The Council shall consist of the officers of the club, the Business Manager, and up to seventeen additional members. In addition, the retiring President shall continue as a member of the Council for the club year following his retirement."

Motion 4: that Article 18 be supplemented by the following statement: "The Vice-President shall be a member of the Finance Committee."
Seconded by C. Gruchy.

Motion 5: that Article 19 be supplemented by the following statement:
"He shall receive and deal with proposed motions to amend the constitution pursuant to Article 24."
Seconded by R. Foxall.

Motion 6: that Article 21 be supplemented by the following statement:
"He shall be a member of the Finance Committee."
Seconded by I. Sutherland.

Motion 7: that the second paragraph of Article 14 be deleted and replaced by the following:
"The Council shall, at the earliest possible date, appoint chairmen and members of Standing and Special Committees, and Editors and Business Managers, as required, for club publications."
Seconded by S. Thomson.

Motion 8: that Article 15 be deleted and replaced by the following:
"All members of the Council, auditors, and committee members elected or appointed pursuant to Articles 10, 12, and 14 shall commence their duties at the close of the meeting at which they are elected or appointed, and shall serve until the end of the next Annual Business Meeting or until their successors are appointed. Appointments of Editors and Business Managers of club publications pursuant to Article 14 shall be for specified terms not exceeding three years, and shall be renewable."
Seconded by G. Neville.

These motions will be voted upon at the 96th Annual Business Meeting in January 1975.

(Signed)
Donald A. Smith
26 January 1974

The Ottawa Field-Naturalists' Club Balance Sheet

as at December 31st, 1973.

Assets

Current				
Cash in Bank and on hand		$13,267.14	
Cash in Savings Account		81.00	
Bills Receivable		1,593.42	
Accrued Interest Receivable		3,926.26	$18,867.82
Fixed (at cost)			
Furniture, fixtures and equipment		529.50	
Less Accumulated depreciation		258.40	271.10
Investments and Securities			
Bell Telephone Company of Canada			
35 common shares	$1,617.20		
2 preferred shares	94.00		
Microsystems International Ltd.			
2 shares	20.00	1,713.20	
Canada Savings Bond		10,700.00	12,431.20
			31,570.12

Liabilities and Equity of Surplus

Current Liabilities		
Income Received in Advance	4,499.60	
Accounts Payable	7,210.56	11,710.16
Equity of Surplus		
Balance December 1st, 1972	16,054.40	
Add Net Income for the Period	3,805.56	19,859.96
		$31,570.12

(Signed) F. M. Brigham, Auditor
H. Williamson, Auditor
C. Gruchy, Treasurer

The Ottawa Field-Naturalists' Club Statement of Profit and Loss

for the thirteen-month period ending December 31st, 1973.

Income		
Net Income from The Canadian Field-Naturalist		$ 716.38
Other Revenue		
Membership Income	$5,518.70	
Sale Income	40.55	
Subscriptions Trail & Landscape	6.00	
Back Numbers Trail & Landscape	22.70	
Interest, Income and Dividend	1,522.75	7,110.70
		7,827.08
Less Cost of Publication		
Trail & Landscape Volume 7	1,381.24	
Circulation	83.84	
Office	24.39	
Honoraria	250.00	1,739.47
Gross Profit on Operations		6,087.61
Less Operating Expenses		
Special Activities	66.41	
Council Expenses	202.98	
Printing & Stationery	306.94	
Membership Committee	605.74	
Excursions & Lectures	108.28	
Bird Records Committee	55.13	
Bird Feeder	150.68	
Research & Briefs	4.00	
Macoun Club	494.01	
Delegation Expenses	40.00	
Orchid Survey	18.69	
F.O.N. Scholarship	125.00	
Bank Charges & Interest	36.41	
Depreciation Expense	67.78	2,282.05
Net Income		3,805.56

The Canadian Field-Naturalist Statement of Profit and Loss

for the thirteen-month period ending December 31st, 1973.

Revenue			
Membership Income		$ 3,689.80	
Subscription Income		5,824.60	
Grants — National Research Council of Canada	$3,000.00		
— Canadian National Sportsmen's Show	750.00	3,750.00	
Reprints		2,079.15	
Plates & Tab Settings		1,513.61	
Extra Pages		652.30	
Back Numbers		3,439.45	
Special Publications		61.50	$21,010.41
Less Cost of Publications			
Volume 87 (No's. 1, 2, 3, 4)		12,405.50	
Plates & Tab Settings		1,811.50	
Reprints		1,966.99	16,183.99
Gross Profit on Operations			4,826.42
Less Operating Expenses			
Circulation		594.94	
Office Assistant		1,612.81	
Postage		69.31	
Printing & Stationery		390.08	
Maintenance & Repairs		15.00	
Editing, Contracts		375.00	
Editing, General Expenses		408.90	
Business Manager's Expenses		194.00	
Honoraria		450.00	4,110.04
Net Income			716.38

Information Concerning Content of The Canadian Field-Naturalist

Articles

The Canadian Field-Naturalist is a medium for publication of research papers in all fields of natural history. If possible, major articles, especially those dealing with the environmental issues of our time, should be illustrated.

Notes

Short notes on natural history and environmental topics written by naturalists and scientists are welcome. Range extensions, interesting behavior, pollution data, and other kinds of natural history observations may be offered. It is hoped, however, that naturalists will also support local natural history publications.

Letters

Letters commenting on items appearing in this journal or on any developments or current events affecting natural history and environmental values are welcome. These should be brief, clear, pertinent and of interest to a wide audience.

News and Comment

Informed naturalists, biologists and others are invited to present documented narratives and commentaries upon current scientific and political events that affect Canadian natural history and the environment. Contributions should be as short as possible and to the point.

Book Reviews

Normally, only solicited reviews are published. However, biologists and naturalists are invited to submit lists of titles (complete with pertinent information regarding authors, publisher, date of publication, illustrations, number of pages and price) for listing under "New Titles".

Special Items

As The Canadian Field-Naturalist has a flexible publication policy, items not covered in the traditional sections can be given a special place provided they are judged suitable.

Reprints

Reprints with or without covers may be purchased. All reprint orders should be sent to the Business Manager, The Canadian Field-Naturalist, Box 3264, Postal Station 'C', Ottawa, Canada K1Y 4J5, as soon as possible after receipt of the galley and reprint order form. Members in good standing making personal purchases may request a 10% reduction in reprint costs.

Schedule of charges for reprints

Number of Reprints	1 to 4 journal pages	5 to 8 journal pages	9 to 12 journal pages	13 to 16 journal pages	17 to 20 journal pages	Additional charge for Mayfair covers
100	16.00	21.00	32.00	43.00	54.00	15.00
200	20.00	27.00	40.00	53.00	66.00	22.00
300	24.00	33.00	48.00	63.00	78.00	29.00
400	28.00	39.00	56.00	73.00	90.00	36.00
500	32.00	47.00	64.00	83.00	102.00	43.00

Instructions to Contributors

Manuscripts

Authors should submit three complete manuscripts with two copies of figures (in addition to the originals) for use by referees. Manuscripts are accepted in either English or French. They should be typewritten on paper measuring 8½ x 11 inches, and if possible, the paper should have numbered lines. Margins should be 1 to 1½ inches wide to allow for copy marking. All text matter, including quotations, footnotes, tables, literature citations and captions for figures should be double-spaced. Only words meant to appear in italics should be underlined. Every sheet of the manuscript should be numbered. In no case should words be abbreviated; this includes references to tables and figures as well as literature citations.

It is strongly recommended that, before submitting a paper, authors ask qualified persons to appraise it.

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THE CANADIAN FIELD-NATURALIST PUBLISHED BY **The Ottawa Field-Naturalists' Club**

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Cover photograph: Herring Gull colony on Pigeon Island in the lower Great Lakes. Canadian Wildlife Service photograph by Karl Himmer. See article and notes on pages 273, 354, and 356.

The Canadian Field-Naturalist

VOLUME 88 JULY-SEPTEMBER, 1974 NUMBER 3

Pollutants in Breeding Herring Gulls in the Lower Great Lakes

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Gilbertson, Michael. 1974. Pollutants in breeding Herring Gulls in the lower Great Lakes. Canadian Field-Naturalist 88: 273–280.

Abstract. Severe reproductive failures have occurred in Lake Ontario colonies of Herring Gulls. The reproductive failures were characterized by poor hatchability of the eggs and by eggshell breakage and flaking. Eggs which were analyzed for organochlorine substances showed severe contamination with DDE and PCB. Eggshell thinning was found in all the colonies studied in the lower Great Lakes but was greatest in Lake Ontario and was correlated with the content of DDE in the eggs.

Introduction

Herring Gull (*Larus argentatus*) colonies in certain parts of the Great Lakes exhibit low breeding success. Keith (1966) reported that embryonic mortality was a significant factor causing poor breeding success in a colony in Green Bay, Lake Michigan. Dead eggs in the colony were characterized by shells which fractured and chipped. Ludwig and Tomoff (1966) described essentially similar observations in a colony in Grand Traverse Bay, Lake Michigan. Hickey and Anderson (1968) showed that eggshell thickness of Herring Gull eggs collected from the Great Lakes in 1967 was significantly thinner than in eggs collected in the same year from the Eastern Seaboard. No such geographic variation was found in eggs from these locations collected prior to 1947.

Hickey and Anderson (1968) further showed that there was a significant inverse correlation between eggshell thickness in Herring Gull eggs from the Great Lakes and the Eastern Seaboard and their content of DDE. The Lake Michigan colonies which showed low breeding success contained eggs with high concentrations of the organochlorine substance DDT and its metabolites, chiefly DDE. The observed embryonic mortality may therefore have been related to DDT and its metabolites. Since 1967, however, and therefore after the Lake Michigan work was undertaken, several other organochlorine substances, particularly PCBs, have been detected and may have contributed to or caused this phenomenon.

The objective of the present study undertaken in 1972 was to extend this existing knowledge, by investigating breeding success, eggshell thickness, and organochlorine residues in the eggs of this species to assess the severity of the effects of these substances on reproduction of Herring Gulls nesting in different locations on the lower Great Lakes.

The Herring Gull appears to be a useful indicator organism for an assessment of the scale to which an aquatic environment has become contaminated by toxic chemicals, and the effect of these chemicals upon species breeding in the vicinity. The characteristic which makes this species a valuable indicator organism, particularly in the lower Great Lakes, lies in the non-migratory behavior of the adult breeding population (Kadlec and Drury 1968), which is assumed to result in residues which reflect the local environmental contamination. Furthermore, the ubiquitous distribution and colonial breeding habits, the synchrony of arrival and egg laying, the building of a nest which diminishes the effect of the local substrate on the eggs, the partial dependence on a food supply independent of the vagaries on fish abundance, and the relatively invariable mean clutch size contribute to its value as an indicator organism. Other factors are the demonstrable relationship between eggshell thickness and the content of DDE and the high levels of other organochlorine and mercury residues which are accumulated by this species in this region (Ontario Research Foundation reports

to the Canadian Wildlife Service under contract CWS 72/73-005).

Methods

The distribution of Herring Gull colonies was investigated early in the breeding season. Six colonies were selected for estimating breeding success and these were visited approximately once weekly when weather permitted. Seven other colonies were visited and samples of eggs were removed but no estimate of breeding success was made. During each visit to the colonies where breeding success was being estimated, the number of nests and of eggs were determined. A small sample of eggs was removed from these colonies to determine eggshell thickness, measured by a dial micrometer, and to determine the content of organochlorine residues by the method outlined by Reynolds (1969). Chicks which hatched on the islands were identified by banding. Eggs which did not hatch but which were fully incubated were collected and the stage of development at death estimated.

The distribution of the 13 colonies which were studied is shown in Figure 1. There was one colony in the St. Lawrence River on Black Ant Island; colonies studied in eastern Lake Ontario were located on Pigeon Island (See Figure 2), southwest of Wolfe Island; on two islands in the Kingston Basin, Snake Island and Brother Island; on Scotch Bonnet Island and Nicholson Island; and Presqu'ile Provincial Park. The only colony visited in western Lake Ontario was on Muggs Island near Toronto. Colonies were located at Port Colborne and Port Maitland (Mohawk Island) in eastern Lake Erie and on Big Chick Island in the west basin. Two colonies were visited in the Georgian

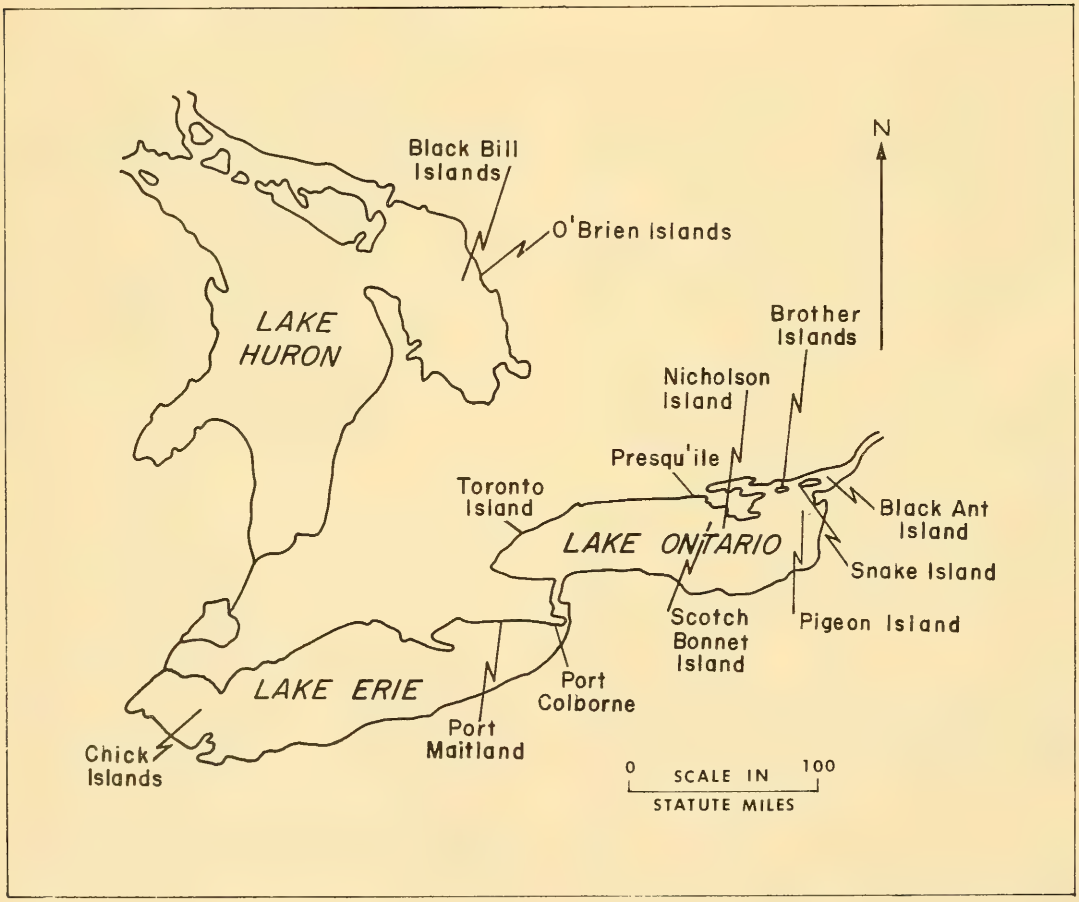

FIGURE 1. Distribution of Herring Gull colonies.

FIGURE 2. Herring Gull colony on Pigeon Island. Canadian Wildlife Service photograph taken in the summer of 1972 by Karl Himmer.

Bay region of Lake Huron; one was located on the Black Bill Islands and the other two on the O'Brien Islands, both off Pointe au Baril.

Results and Discussion

Breeding Success

Table 1 shows the breeding success of those gull colonies where it was measured. In the Kingston Basin only 0.10–0.21 chick was produced per pair of breeding adults. In the other Lake Ontario colonies, breeding success was as low or lower. There was an indication that success was higher on Big Chick Island in Lake Erie; the island was periodically inundated by storms and by the unusually high water conditions which prevailed in 1972, and a reliable estimate of breeding success could not be made.

The principle cause of the poor breeding success was the high proportion (about 30%) of eggs which did not hatch, an observation similar to those made in Lake Michigan in 1964 (Keith 1966). Dead eggs were frequently found dented or broken. Many of the dead eggs were decomposed and thus it was not possible to estimate accurately the proportion of eggs which died at different stages. Most, however, were embryonated.

Several publications report estimates of the breeding success of Herring Gulls, and these have been reviewed by Keith (1966) and by Kadlec and Drury (1968). Keith showed that the 0.3–0.4 fledged young per pair of adults produced in the

TABLE 1 — Breeding success of Herring Gulls in colonies in Lake Ontario and Lake Erie

Location	Number of pairs	Number of fledged young	Number of fledged young/pair
Lake Ontario			
Brother Islands	40	4	0.10
Snake Island	85	18	0.21
Scotch Bonnet Island	142	17	0.12
Presqu'ile Provincial Park	18	1	0.06
Black Ant Island	13	1	0.08
Lake Erie			
Big Chick Island	287	100–150	0.35–0.52

Green Bay colony was considerably below other published values (0.5–1.2) for the production of juveniles. Kadlec and Drury estimated that the usual range of the rate of production was from 0.8–1.2 young per breeding pair on the New England coast. Thus the results of the studies from the colonies on Lake Ontario show that the breeding success is at about one tenth of that on the coast.

Eggshell Thinning and Pollutant Concentrations

Since eggshell thinning has been documented in this species and a relationship found with the content of DDE (Hickey and Anderson 1968), and since egg breakage appeared to be an important phenomenon amongst these colonies, the thickness of all eggs collected was measured and two eggs from each colony were analyzed for DDE residues. Figure 3 shows the mean eggshell thickness on a colony basis for the eggs taken during the first laying versus the mean of the DDE determinations. Eggs from Lake Erie were considerably thicker than those from colonies in Lake Ontario. Samples from Georgian Bay were intermediate.

The mean thickness of eggshells from the Eastern Seaboard was 0.380 mm in 1967 (Hickey and

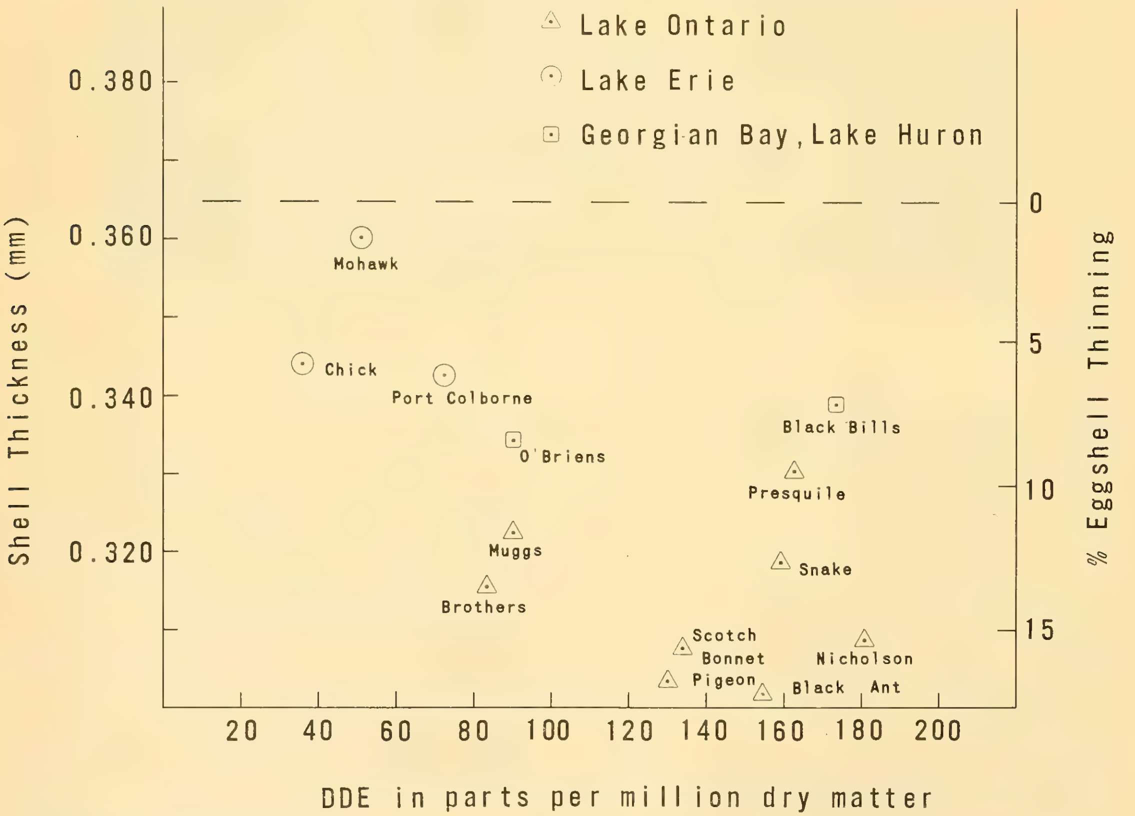

FIGURE 3. Relationship between mean eggshell thickness and mean DDE content of eggs on a colony basis.

Anderson 1968). The thickness of 456 eggshells from the Great Lakes prior to 1947, and thus prior to the introduction of DDT, was 0.375 mm (Anderson and Hickey 1972). This latter figure shows that the percentage of eggshell thinning in Lake Ontario colonies varied between 9% (Presqu'ile) and 16% (Pigeon Island). In Lake Erie it varied between 1.3% (Mohawk Island) and 5.6% (Port Colborne) in 1972.

In all the colonies studied eggshell breakage and flaking occurred frequently (see Figure 4). These phenomena have not been reported for the less contaminated colonies on the Eastern Seaboard. Ludwig and Tomoff (1966), however, described these occurrences in colonies in northern Lake Michigan, and Keith (1966) similarly reported finding these in the Green Bay colony, where the mean eggshell thinning in 1964 was 15% (Anderson et al. 1970).

Figure 5 shows the distribution of the thickness of the eggshells versus their content of DDE. There was a significant inverse Spearman rank correlation coefficient ($r = -0.4883$, $P < 0.05$) between eggshell thickness and content of DDE. The distribution suggested a non-linear relationship and thus product moment correlation coefficients were calculated on the logarithmic transformations of the data. The highest correlation coefficient was between log DDE and thickness ($r = 0.6039$), and the corresponding least squares regression line is shown on Figure 5. This logarithmic regression line is curvilinear when drawn with untransformed axes.

A stepwise linear regression analysis of thickness as a function of DDE, dieldrin, heptachlor epoxide, hexachlorobenzene, PCB, mercury and their logarithms showed a significant ($F_{1,24} = 13.48$, $P < 0.01$) regression of thickness on log DDE and a 36% reduction of the sums of squares. None of the other variables produced a significant further reduction in the sums of squares. The majority, if not all of the remaining variation, probably reflects the expected natural variation.

Embryonic Mortality

The incidence of embryonic mortality is more difficult to evaluate. Kadlec and Drury (1968) reported that only 2% of the eggs laid in their colonies on the Eastern Seaboard were found dead within the first three weeks. Keith (1966) found about 35% mortality in the Green Bay colony and Ludwig and Tomoff (1966) found 56% dead or infertile in the colony in Traverse Bay, Lake Michigan. Both these colonies contained eggs with high concentrations of organochlorine substances, principally DDE with lower amounts of dieldrin. Eggs from fish-eating birds from the lower Great Lakes contain hexachlorobenzene (Gilbertson and Reynolds 1972) and poly-

FIGURE 4. Herring Gull egg showing eggshell flaking and chick which pipped and died before hatching. Canadian Wildlife Service photograph taken on Pigeon Island in the summer of 1972 by Karl Himmer.

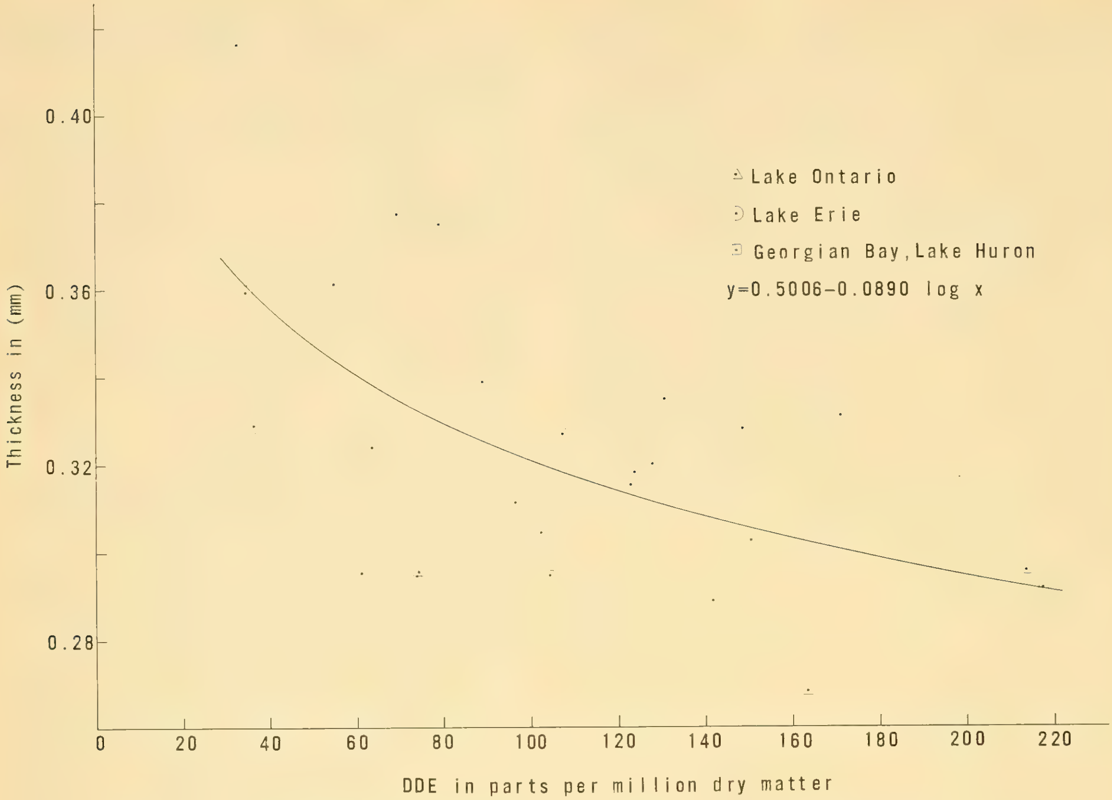

FIGURE 5. Relationship between eggshell thickness and DDE in individual Herring Gull eggs.

chlorobiphenyls (PCBs). DDT and DDD were found among some eggs from some locations but were frequently below the level of detection, and their combined quantity was less than 1% of the quantity of DDE. Further analytical studies have been performed on eggs taken from Scotch Bonnet Island and these have indicated that there are other organochlorine substances, as yet unidentified, in the eggs from this island (Bowes et al. 1973). The toxicity of these substances has yet to be determined for embryos and thus it is difficult to implicate any particular substance or group of substances.

Further, the concentrations of the organochlorine substances which were quantified were correlated with each other and this correlation was apparently independent of the geographic source of the egg. The correlation coefficients are set out in Table 2. This high correlation between the several substances makes it uncertain as to which substance caused the mortality of the embryos.

Embryonic mortality has been documented experimentally for some of the organochlorine substances found in this study. Heath et al. (1969) found increased embryonic mortality amongst eggs from Mallards (*Anas platyrhynchos*) fed 10 ppm in the feed. Baxter et al. (1969) found decreased hatchability of eggs from Pheasants (*Phasianus colchicus*) dosed with capsules of dieldrin. The levels found in the Pheasant eggs were much higher than those found in the Herring Gulls in the Great Lakes. Hexachlorobenzene (HCB) has been investigated for its effect upon hatchability of poultry eggs (Avrahami and Steele 1972). No decrease in hatching success was noted even with 330 ppm present in the yolk of the eggs. The composition of the chicken egg (Romanoff and Romanoff 1949) is such that parts per million in the yolk on a wet-weight basis is nearly equivalent to parts per million in the whole egg on a dry-matter basis. The levels of HCB did not exceed 10 ppm on a dry-matter basis in the Herring Gull eggs. Tumasonis

TABLE 2 — Correlation coefficient between organochlorine substances in Herring Gull eggs from colonies in three Great Lakes

	Correlation coefficient		
	Dieldrin	HCB	PCB
DDE	0.3901	0.6067	0.8656
Dieldrin		0.4574	0.3619
HCB			0.7905

et al. (1973) showed that embryonic mortality was increased in eggs from poultry administered PCB in water. Death of embryos was found at levels in the yolk above 10–15 ppm on a wet-weight basis, which is nearly equivalent to 10–15 ppm in the whole egg on a dry-matter basis. All the Herring Gull eggs collected from the Great Lakes are between one and two orders of magnitude above this effective level in poultry eggs. It would seem that the most probable major cause of the embryonic mortality is the presence of DDE and PCB in the eggs, though the other organochlorine substances may have contributed to the overall toxic effect on embryos.

Organochlorine Substances Correlated

The marked correlations between organochlorine substances in eggs collected from the different

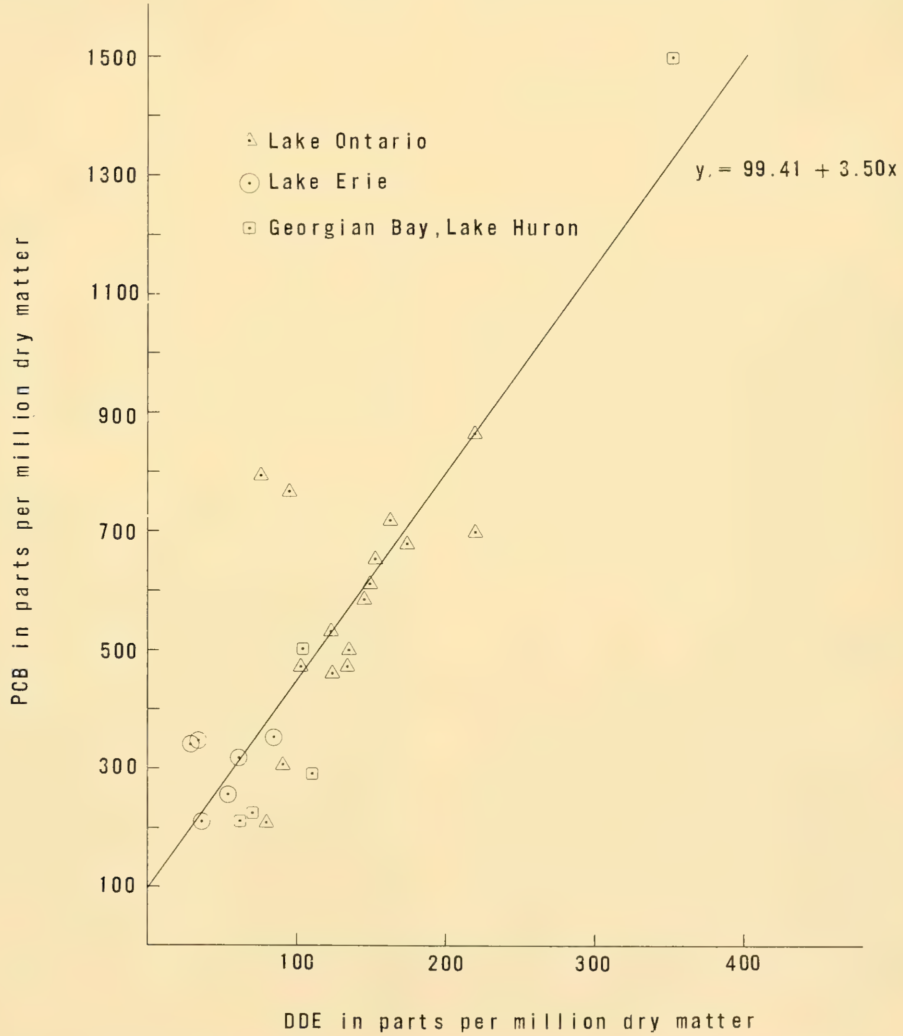

FIGURE 6. Relationship between PCB and DDE in individual Herring Gull eggs.

lakes are worthy of further research to try to evaluate how this correlation has occurred. The highest correlation was between DDE and PCB ($r = 0.8656$), indicating that the ratio of these two substances is constant amongst eggs from first clutches. Figure 6 shows the distribution of the concentrations of DDE versus PCB and the line of best fit to the data. There is a close resemblance between the form of Figure 6 and the corresponding figure of DDE versus PCB in Brown Pelican eggs from Florida (Schreiber and Risebrough 1972). The PCB/DDE ratio in the Florida eggs ranged, on a colony basis between 2.3 : 1 and 3.7 : 1 and this is comparable to the ratio of 3.5 : 1 in the Great Lakes Herring Gull colonies. In the Florida Pelican study the authors interpreted the constancy of the ratio as indicating that both these compounds move in similar ways through marine food chains.

Conclusion

This paper indicates that of the three lower Great Lakes, Lake Ontario is the most severely contaminated with toxic organochlorine substances. This contamination is correlated with low breeding success among Herring Gulls which is only one-tenth that of the success of less contaminated colonies on the Atlantic coast. The characteristics of the breeding failure were a low incidence of hatching of eggs and a high incidence of egg breakage and flaking. Eggshell thinning was found to be related to the content of DDE.

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I am indebted to Dr. L. M. Reynolds for the analysis of organochlorine residues, to Mr. J. A. Keith, Ms. I. Price, and Mr. S. M. Teepie for their help in the field work, and to Mr. R. Hale for processing the eggs. Dr. R. D. Morris and Mr. R. Simpson collected the samples and undertook the field work in Lake Erie. Dr. G. E. J. Smith and Mr. W. E. Walker II gave me valuable advice concerning statistics, and Dr. R. W. Risebrough gave me encouragement and advice throughout the project.

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Ecological Distribution of Birds in the Atigun and Sagavanirktok River Valleys, Arctic Alaska

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Sage, B. L. 1974. Ecological distribution of birds in the Atigun and Sagavanirktok River Valleys, Arctic Alaska. Canadian Field-Naturalist 88: 281–291.

Abstract. The results of observations made in the Atigun and Sagavanirktok River Valleys and their associated tributaries in the northern foothills of the Brooks Range and central Arctic Slope of Alaska are discussed. During the period 1969–1971 a total of 72 species were recorded, of which 35 were proved to breed, and a further 13 species are believed to have done so. The ecological characteristics of the available avian habitats in the study area are described. Records of particular interest include the first occurrence of the Black-billed Magpie north of the Brooks Range, the occurrence of the Yellow-shafted Flicker, and the breeding of Least Sandpiper and Cliff Swallow. Comparisons are made between the ornithology of the Atigun and Sagavanirktok Valleys and that of the Colville River.

Introduction

Until relatively recently most of the published data on the avifauna of the Arctic Slope of Alaska referred to studies carried out in the coastal regions, particularly in the west. Kessel and Cade (1958), however, summarized the available data on the birds of the Colville River, the largest drainage system on the north side of the Brooks Range. Further information was added by West and White (1966). Maher (1959) dealt with the breeding birds of the upper Kaolak River, an area some 128 km northwest of the upper Colville, and Irving (1960) gives a detailed analysis of the birds of the Anaktuvuk Pass area.

The discovery in 1968 of large reserves of oil at Prudhoe Bay, and the subsequent plans for construction of a pipeline from the oilfields south to Valdez on the Gulf of Alaska, served to emphasize the relative lack of ornithological data from that section of the Arctic Slope bounded by the Colville River to the west and the Canning River to the east. The present paper discusses studies made in part of this area. More recently plans have been announced for the building of a natural gas pipeline from Prudhoe Bay through to Canada, and the probable route of this pipeline will pass through part of the study area of this paper.

The oil developments have led to increased biological research on the Arctic Slope, including intensive studies of waterfowl distribution and density, particularly in the coastal area of the central section, and to a certain amount of work on waders and passerines, under the auspices of the Tundra Biome Program of the U.S. International Biological Program. Exploration and drilling for oil in various parts of Arctic Canada has led to a somewhat similar increase in observational activity in that area.

In view of probable future developments on the Arctic Slope it is desirable to publish the results of preliminary surveys to provide a base line from which future changes may be assessed.

The present paper summarizes studies on the birds of the Atigun and Sagavanirktok River Valleys, and is based on field work carried out from July to October 1969, April to November 1970, and in June 1971. All locality names used are taken from the 1:250,000 scale maps of the United States Geological Service Alaska Topographic Series, the relevant sheets being, from north to south, Beechey Point, Sagavanirktok, and Philip Smith Mountains.

In view of the frequent mention in this paper of Umiat on the Colville River, a brief explanation of the climatic conditions there is advisable. Umiat has a temperature regime that is noticeably more continental than that at the coastal localities of Barrow and Prudhoe Bay in the north. The temperature extremes at Umiat are greater than is the case at either of these two localities. The growing season (not to be confused with the frost-free season) is longer and warmer at Umiat, where surface temperatures of up to 100° F have been recorded. As pointed out by Spetzman (1951), Umiat is in an area which probably has the most favorable growth conditions on the Arctic Slope, and this is reflected in the relatively luxuriant development of *Salix* in that area. This may well explain the occurrence on the Colville River of certain passerine species that have not so far been recorded in my study area, as detailed later in this paper.

Study Area

Both the Atigun and Sagavanirktok Rivers have their source on the north side of the Brooks Range immediately below the Continental Divide. The former river flows north for about 32 km to Galbraith Lake at 149°29′ E, 68°28′ N, at which point it bends almost due east to flow for 14 km through the Atigun Canyon. At the eastern end of the Canyon the Atigun joins the Sagavanirktok at the confluence of the two arms of that river. The Sagavanirktok River then flows north for about 209 km to the Beaufort Sea. During their combined course of about 257 km these rivers flow through the Arctic Mountains (Central Brooks Range), the Arctic Foothills, and the Arctic Coastal Plain Provinces of Alaska as defined by Wahrhaftig (1965).

The Arctic Coastal Plain rises gradually from the north coast to a maximum of about 183 m at its southern margin. About 40 km south of the coast, however, Franklin Bluffs rise to a maximum elevation of 293 m above the east side of the Sagavanirktok River for a distance of nearly 32 km. Some 26 km southwest of Franklin Bluffs are the White Hills, which attain a maximum elevation of about 396 m. The course of the Sagavanirktok River through this province is very braided with numerous gravel bars and terraces.

The part of the Arctic Foothills Province relative to this study consists of rolling plateaus and low mountains rising to about 366 m, and with many broad east-trending ridges, interspersed with undulating tundra plains. The Central Brooks Range section of the Arctic Mountains Province is a rugged, glaciated east-trending ridge with mostly accordant peaks rising to 2134–2438 m in altitude on the north side. The Atigun River has two main arms coming down from the Continental Divide and is supplemented by a number of minor streams originating from small icefields in the surrounding mountains. The Sagavanirktok River, north of the confluence of its two main arms and the Atigun River, has a number of large tributaries. From south to north they are Section Creek, Accomplishment Creek, Ribdon River, Lupine River, and the Ivishak River, all entering from the east.

The area dealt with in this paper is basically the two main river valleys and the lower sections of the main tributaries, extending up to the summits of the immediately adjacent mountains. I have taken the northern end of Franklin Bluffs as the northern limit, thus excluding the delta area of the Sagavanirktok River, where I have done only limited field work. To the west of the bluffs the boundary is not well defined, but basically I have included the tundra lakes within 3 km or so of the Sagavanirktok River, and the lakes lying between the White Hills and Franklin Bluffs. The small streams on the tundra just to the east of the airstrip known as Sagwon, about 48 km south of Franklin Bluffs, are also included in the area covered, although most of them drain into the Ivishak River. The southern boundary is, of course, formed by the watershed of the Atigun and Sagavanirktok Rivers at the Continental Divide of the Brooks Range.

The general topographical and ecological characteristics of the Arctic Slope in general are well described by Spetzman (1959), Wiggins and Thomas (1962), Wahrhaftig (1965), and Brooks (1970).

Ecological Divisions

For the purpose of analyzing the distribution of birds noted during the course of this work the study area has been divided into 10 main habitat types, based on the life-form of the vegetation. This is the method used by Williamson (1957) in his study of the birds of the Napaskiak area in the Kuskokwim River delta, and by Kessel and Cade (1958) for the Colville River. The habitat categories in all three of these studies are the same, except that I have included the riparian cut-banks habitat as part of the fluviatile waters habitat, my reason for this being that I do not have sufficient data to treat riparian cut-banks as a separate entity.

In the following habitat descriptions and throughout the text, the plant names used are those of Hultén (1968).

1. *Sedge-grass Marsh*. This habitat is primarily found on low-level, poorly drained terrain, particularly in the vicinity of lakes and on valley floors, and in the low centers of polygonal ground. In its driest form the substrate of this habitat is saturated, and at the other extreme, water may lie on the surface to a depth of several centimeters. In appearance this habitat has the general aspect of grassland and is dominated by species of sedge such as *Carex aquatilis* and *C. chordorrhiza*, which are often associated with *Equisetum* and *Juncus* species. Scattered on slightly drier and elevated areas within this habitat are tussocks of cottongrass, such as *Eriophorum vaginatum* and *E. angustifolium*.

2. *Tussock-heath Tundra.* This is the dominant plant community in the foothills, reaching its maximum development on moist, reasonably well-drained soils which may, however, be very wet at certain times, such as after persistent heavy rains (as in 1969) or during the spring thaw. Characteristically this habitat consists of tussocks of cottongrass of which *Eriophorum vaginatum* is the dominant species, and with which may be associated *Dryas* and *Salix* species. These tussocks show considerable variation in size and density, but typically reach 15 to 25 cm in height and a little less in width. They are separated by narrow channels in which grow mosses and lichens.

3. *Dwarf Shrub.* This is a fairly common habitat occurring in a number of situations, but usually occupying only limited areas. It is characteristic of the riparian vegetation of small drainage streams, but also occurs on the margins of lakes and on saturated ground where it merges with the sedge-grass marsh habitat. It is also found to a certain extent on the gravel of river terraces and floodplains. Basically this habitat can be defined as consisting of shrubs reaching no more than about 90–100 cm in height. The dominant species are dwarf birch (*Betula nana*), stunted alder (*Alnus crispa*), and several species of willows such as *Salix pulchra* and *S. lanata*.

4. *Tall Brush.* This is defined as brush exceeding 90–100 cm in height and it is not a common habitat in the area under discussion. It is found only in the foothills where it is confined to the rivers and drainage channels. There is very little of it in the Atigun River Valley, but it may be found to a certain extent in the Sagavanirktok River Valley and some of its tributaries such as the Ribdon River. The principal species in this habitat is the willow *Salix alaxensis*.

5. *Tundra-lacustrine Water Edge.* This is an extensive habitat, particularly on the coastal plain where lacustrine waters comprise such a large part of the total surface area. In the majority of cases the edge habitat is sedge-grass marsh, but occasionally tussock-heath tundra may reach the water's edge.

6. *Dry Tundra.* Mainly a habitat of the higher elevations, but occurring also on bluffs, steep slopes, and elevated hummocks in lower areas, this habitat is characterized by much bare ground with a prostrate vegetation of species such as *Dryas octopetala* or *D. integrifolia, Silene acaulis, Arctostaphylos alpina*, and lichens.

7. *Bluffs and Cliffs.* This is an extensive habitat along the Atigun River and the upper reaches of the Sagavanirktok River, becoming less common as one travels north. The northern limit of this habitat in the study area is at Franklin Bluffs. Farther south towards the Continental Divide are many cliffs and bluffs between the 610-m and 914-m contours, and higher still near the base of the mountains.

8. *Alluvial Deposits.* These consist of gravel and silt bars and islands, which are a common feature of the very braided valleys of most of the rivers in this area. This habitat is generally almost devoid of vegetation, but where they are not regularly submerged, species of *Equisetum* may grow in silt, and in rare instances dwarf willows may occur. Part of the floodplain of the Sagavanirktok River below Franklin Bluffs and in the vicinity of Sagwon have quite extensive growths of willow scrub, but this rarely exceeds knee height.

9. *Fluviatile Waters.* In the present case this habitat includes not only all moving waters, but also the adjacent cut-banks. The latter are formed where the tundra meets the water. As there is much erosion under the prevailing conditions it is an unstable habitat characterized by the breaking off of large undercut sections of tundra which then collapse into the river; it is, therefore of little importance as a nesting habitat.

10. *Lacustrine Waters.* This includes all still bodies of fresh water from tiny ponds to the largest lakes, irrespective of whether they are of a temporary or permanent nature. The lakes vary considerably in both depth and vegetation. Some may be almost devoid of rooted submerged or emergent vegetation, while others have a well developed flora.

Rooted submerged species are uncommon and, where present, consist primarily of *Potamogeton* species. Emergent marginal vegetation often occurs in fairly distinct zones, and from deeper through to shallower water consists typically of species such as *Sparganium hyperboreum, Menyanthes trifoliata, Arctophila fulva* and *Equisetum* species, *Hippuris vulgaris, Eriophorum species, Carex* species, and *Caltha palustris*.

The distribution within these ten habitats of 65 of the 72 species recorded in the Atigun and Sagavanirktok Valleys and their associated tributaries is shown in Table 1. The species omitted from the table are Bald Eagle, Marsh Hawk, Sanderling, Pomarine Jaeger, Sabine's Gull, Yellow-

shafted Flicker, and Black-billed Magpie, all of which occur only rarely in the area under consideration. In the table, I have been mainly concerned with showing the breeding habitat of each species, and I do not suggest that the indications of habitat use for other purposes, such as feeding or resting, are at all complete.

Comparison of the Avifauna of the Atigun and Sagavanirktok Valleys with That of the Colville

The total number of species recorded for the Colville River Valley, based on the papers of Kessel and Cade (1958) and West and White (1966), is 93. For a true comparison with the Atigun and Sagavanirktok River Valleys as defined here, those species known only from the Colville River delta area must be omitted. These number 10 and thus reduce the total for direct comparison to 83 species. The equivalent total for the present area is 72 (this is assuming the presence of only one species of Redpoll), a difference of only 11 species. In view of the fact that the Colville River is the largest drainage system north of the Brooks Range and that it has been much better studied over a longer period than any other Arctic Slope river system, then the difference between the two areas is remarkably small. There is little doubt that further studies in the Atigun and Sagavanirktok Valleys would add more species to the list, particularly of vagrants and migrants.

A total of 19 species recorded from the Colville River have not so far been found in the Atigun or Sagavanirktok Valleys; these are Black Brant,

TABLE 1 — Habitat distribution of 65 species recorded in the Atigun and Sagavanirktok River Valleys 1969–1971. B=breeding confirmed; b=circumstantial evidence of breeding; x=non-breeding records.

Species	Habitat 1	2	3	4	5	6	7	8	9	10
Common Loon										x
Yellow-billed Loon					B				x	x
Arctic Loon					B				x	x
Red-throated Loon									x	x
Red-necked Grebe										x
Whistling Swan					B				x	x
Canada Goose									x	x
White-fronted Goose									x	x
Mallard									x	x
Pintail					b					x
Green-winged Teal					B				b*	x
American Wigeon					b				x	x
Greater Scaup					B				x	x
Oldsquaw					B				x	x
Harlequin Duck					B					
White-winged Scoter										x
Surf Scoter										x
Red-breasted Merganser					B				B*	x
Rough-legged Hawk		x					B	x		
Golden Eagle		x					B			
Gyrfalcon		x				x	B	x		
Peregrine Falcon		x				x	B	x		
Willow Ptarmigan		B	x	x						
Rock Ptarmigan		b	x			b				
Semipalmated Plover								b		
American Golden Plover		B			x	B				
Common Snipe	b				b					
Whimbrel		b			x					
Spotted Sandpiper								b		
Wandering Tattler									x	
Lesser Yellowlegs					x					
Pectoral Sandpiper	b	B			b					
Baird's Sandpiper	b	B			x			x		

Species	Habitat 1	2	3	4	5	6	7	8	9	10
Least Sandpiper		B			x					
Long-billed Dowitcher	B	x			x					
Stilt Sandpiper								x		
Western Sandpiper		x								
Buff-breasted Sandpiper					x					
Bar-tailed Godwit					x					
Red Phalarope										x
Northern Phalarope	B				b					x
Parasitic Jaeger		b**								x
Long-tailed Jaeger		b**			b**					x
Glaucous Gull								B	x	x
Mew Gull					B					x
Arctic Tern	B							B	x	x
Snowy Owl		B								
Short-eared Owl		x								
Say's Phoebe				x			B			
Horned Lark					b					
Cliff Swallow		x					B			
Common Raven		x				x	B	x		
Robin				B						
Wheatear						b				
Arctic Warbler			x	B						
Yellow Wagtail	x	B		b				x	B*	B
Water Pipit						b				
Northern Shrike				B						
Redpoll			B	B						
Savannah Sparrow	x	x	B							
Tree Sparrow	x	x	B							
White-crowned Sparrow				B						
Lapland Longspur	x	B								
Smith's Longspur	B							x		
Snow Bunting						b				

*These three species may occasionally be associated, for nesting purposes, with the riparian cut-banks component of this habitat.
**While no evidence of breeding by these species was obtained during the study period, there can be no doubt that they would breed in years when the rodent populations were at a high level.

Shoveler, Redhead, Common Goldeneye, Pigeon Hawk, Sandhill Crane, Black-bellied Plover, Killdeer, Dunlin, Semipalmated Sandpiper, Herring Gull, Western Wood Pewee, Tree Swallow, Gray-cheeked Thrush, Bluethroat, Yellow Warbler, Slate-colored Junco, Fox Sparrow, and Gray Jay. I have, however, seen the Gray Jay in the Ivishak Valley, 35 km east of the Sagavanirktok Valley.

Conversely, the following nine species have been recorded in the Atigun/Sagavanirktok Valleys, but not in the Colville: Common Loon, Bald Eagle, Wandering Tattler, Western Sandpiper, Sanderling, Sabine's Gull, Cliff Swallow, Snowy Owl, Black-billed Magpie.

The delta areas of both these river systems are excluded from these calculations. Some of the species mentioned above can only be regarded as vagrants to the Arctic Slope. More extensive field coverage will, no doubt, alter this picture.

So far as breeding species are concerned, the Atigun and Sagavanirktok Valleys, on the basis of the data at present available, have 35 species confirmed as breeding and a further 13 which almost certainly breed, but for which definite evidence is still lacking. An analysis of the Colville River data indicates that about 56 species have bred or are suspected to breed. That is to say, the Colville drainage system has about eight more breeding species than the Atigun or Sagavanirktok Valleys.

Species recorded as breeding or believed to be breeding in the Colville River Valley and not in the area covered by this paper, are Red-throated Loon, Red-necked Grebe, Canada Goose, Shoveler, Surf Scoter, Semipalmated Sandpiper, Buff-breasted Sandpiper, Pomarine Jaeger, Herring Gull, Short-eared Owl, Gray Jay, Gray-cheeked Thrush, Bluethroat, Yellow Warbler, Wilson's Warbler, and Fox Sparrow, a total of 16 species. Conversely, breeding species for the Atigun and Sagavanirktok Valleys not known to breed on the Colville are Yellow-billed Loon, Baird's Sandpiper, Least Sandpiper, Mew Gull, Snowy Owl, Cliff Swallow, and Snow Bunting, a total of only seven species. Further work in both areas may well result in some amendments to this picture.

Species Accounts

Gavia immer. Common Loon. A pair of these loons appeared on a lake in the Ribdon Valley on 29 June 1970, but remained for only a few minutes. No trace of these birds could be found in the area the next day. This loon can only be regarded as a straggler to the area and it is apparently an uncommon species north of the Brooks Range. No records for the Arctic Slope are given by Bee (1958), and Kessel and Cade (1958) give no records for the Colville. Irving (1960), however, mentions occurrences in Anaktuvuk Pass and adjacent areas, and concludes that it is regularly present and sometimes nests.

Gavia adamsii. Yellow-billed Loon. There is little doubt that this is the rarest of the three species of loon that breed regularly on the Arctic Slope. In July 1969 a pair with two young were located on a large lake about 16 km south of Franklin Bluffs. They were present again in 1970 and 1971 but did not succeed in rearing any young. A pair with a nest containing two eggs was found in the Ribdon Valley in June 1970. Non-breeding records include occasional birds seen in the Lupine River Valley, on the Sagavanirktok River, and on lakes between Franklin Bluffs and the White Hills. The breeding biology and ecology of this loon on the Arctic Slope is discussed by Sage (1971).

Gavia arctica. Arctic Loon. This is the only numerous loon in the area under discussion. In 1969 there were at least two breeding pairs on the lakes between Franklin Bluffs and the White Hills and several pairs on the lakes about 16 km south of Franklin Bluffs. In 1970 a total of at least 10 pairs were located in the Ribdon, Lupine, and Sagavanirktok Valleys, but there were none in the latter valley south of its junction with the Ribdon. A pair on Galbraith Lake were the only ones found in the Atigun Valley.

Gavia stellata. Red-throated Loon. This species was not noted at all in the Atigun and only twice in the Sagavanirktok Valley, where one was seen on the river just north of the mouth of the Lupine River on 6 June, and another on a pool 5 km south of the Lupine River on 30 June 1970. This species breeds most numerously near the north coast and becomes scarce farther inland.

Podiceps grisegena. Red-necked Grebe. The only record was of one in the Lupine Valley on 3 July 1970; there was sign of a second bird. A nest of this species, with three eggs, was found in July 1949 at the junction of the Itkillik and Colville Rivers (Nelson 1953a), and this appears to be the only breeding record to date in the drainage systems discussed here.

Olor columbianus. Whistling Swan. One or two pairs with nests or young were present on some of the lakes just west of Franklin Bluffs. A pair was present at Galbraith Lake for a few days in June 1970 and this is the only site in the Atigun Valley where they were seen. At the beginning and end of the season, when the tundra lakes are frozen, occasional birds may be seen on the Sagavanirktok River.

Branta canadensis. Canada Goose. I have found no evidence of this species breeding in either the Atigun or Sagavanirktok Valleys. But numbers certainly occur there during the periods of spring and fall migration: for example, 25 on the Sagavanirktok at the north end of Franklin Bluffs on 20 September, and 23 a few kilometers north of the mouth of the Ribdon River on 21 September 1969; groups of 9 and 14 by the river at Franklin Bluffs on 5 June and 20 at Galbraith Lake on 23 June 1970. To a certain extent the breeding distribution of this species on the Arctic Slope is correlated with the existence of bluffs, as pointed out by Nelson (1953b) and by Kessel and Cade (1958) for the Colville River.

Anser albifrons. White-fronted Goose. Within the study area this goose apparently breeds only in the vicinity of the lakes lying between Franklin Bluffs and the White Hills. Flocks doubtless occur on migration in both the Atigun and Sagavanirktok Valleys, as for example about 40 just south of Franklin Bluffs on 5 June 1970.

Anas platyrhynchos. Mallard. This duck appears to be uncommon on the Arctic Slope and has only rarely been proved to breed. A pair was seen on the Sagavanirktok River near its junction with the Lupine River on 6 June, and a pair at Galbraith Lake on 20 May and 23 June 1970.

Anas acuta. Pintail. This species probably breeds in the study area although I have not been able to find nests or young. Angus Gravin (1973) records it as a fairly abundant nester over much of the Arctic Slope. My earliest records are a flock of eight near the junction of the Sagavanirktok and Ribdon Rivers on 11 May 1970, a pair in the same area on 5 June, and two pairs 11 km north of the mouth of the Lupine River on 6 June. On 28 June 1970 two males and four females were on a lake in the Ribdon Valley. A flock of 13 males and four females was seen in the Lupine Valley in late June and early July, and in the latter month up to 10 were seen on some lakes about 32 km further north.

Anas crecca. Green-winged Teal. This species was seen on a number of lakes and streams in both valleys, and females with young were noted. It no doubt breeds regularly in scattered pairs by lacustrine waters and incised streams.

Anas americana. American Wigeon. This species was not seen at all in 1969. In 1970 two pairs were noted on Galbraith Lake on 20 May; a male on the Sagavanirktok River 11 km north of the mouth of the Lupine River on 6 June; and from 30 June to 3 July a flock of 13 males and three females were present on a group of lakes in the Lupine Valley. This wigeon is evidently not a common breeding species on the Arctic Slope. It was classed as a straggler along the Colville River by Kessel and Cade (1958), but it was recorded as breeding at Umiat in 1964 (West and White 1966).

Aythya marila. Greater Scaup. This is probably the most numerous breeding duck in the study area, where it favors the smaller lakes. In 1970 it was present on the Sagavanirktok River early in June before most of the tundra lakes had thawed out. For example, from 5 to 9 June there were at least eight pairs on the river over a distance of about 48 km northwards from the mouth of the Ribdon River, and at least six pairs on partially thawed lakes on the north side of the Ribdon Valley. In the Lupine Valley a flock of up to 14 males and six females was seen from 30 June to 3 July. In early July up to 39 males and 19 females were present on lake 730 and adjacent lakes, some 45 km south of Franklin Bluffs. On 2 July 1970, Dr. John Campbell saw more than 100 adults, including many males, on Galbraith Lake in the Atigun Valley. It is probable that these were all of the present species, but some may possibly have been Lesser Scaup, *Aythya affinis*. Both species are known to occur at Anaktuvuk Pass, and Irving (1960) states that Lesser Scaup breed in the mountains.

Clangula hyemalis. Oldsquaw. This is generally considered to be the most abundant duck on the Arctic Slope as a whole, but in the present study area it was outnumbered by the Greater Scaup. It was found on many of the lakes scattered along both valleys and on the adjacent tundra lakes, but seems to be scarce in the Atigun Valley south of Galbraith Lake. The broods noted usually ranged from six to eight birds.

Histrionicus histrionicus. Harlequin Duck. Despite the apparent suitability of the Atigun and Sagavanirktok Rivers it is apparently rare. In 1970 a male was seen near the mouth of the Ribdon River on 5 June, and another over a lake in this valley on 27 June. A female with young was recorded in 1971 near the junction of the Ivishak and Sagavanirktok Rivers. Occasional individuals occur in the fall on the upper reaches of the Sagavanirktok and in the Atigun Canyon.

Melanitta deglandi. White-winged Scoter. This duck has a scattered distribution on lakes in the study area, but I have been unable to obtain any evidence of breeding. They are usually seen in pairs or very small groups and higher numbers, such as 18 on lake 730 in the Sagavanirktok Valley in late July and early August 1969, probably representing flocking prior to migration.

Melanitta perspicillata. Surf Scoter. In the study area this has proved to be a scarce species with no indication of breeding, probably because it nests on the coastal tundra. They were seen only in 1969, all on lake 730, where two females were noted on 26 July, one on 27 July, four on 28 July, and three on 2 August.

Mergus serrator. Red-breasted Merganser. This species is found on both lacustrine and fluviatile waters. Broods have been recorded at a number of localities from just north of Franklin Bluffs, south as far as the vicinity of Galbraith Lake in the Atigun Valley.

Buteo lagopus. Rough-legged Hawk. A detailed search for nests was made in 1970. None at all were seen in the Atigun Valley, while in the Sagavanirktok Valley a total of five pairs and three single birds were located, and only three pairs hatched any eggs. This may have been partly a result of the low level of the microtine populations in the area in 1970, but the density of pairs was very much lower than recorded for the Colville River. Another factor responsible for the difference in density between the two areas is the presence, in the Colville River Valley, of more bluffs suitable for breeding.

Aquila chrysaetos. Golden Eagle. A 1970 breeding season survey revealed the presence of three breeding pairs in the Atigun Valley. The height above sea level of these three nests was 1,219 m, 1,402 m, and 1,432 m. One recently lined but empty nest was located in the Sagavanirktok Valley. A pair was flushed from a hill in the Lupine River Valley on 2 July, but no nest was found. In addition to the birds associated with these nests, other occasional individuals were seen elsewhere in the study area. Commenting on the status of the Golden Eagle as a breeding species in the Brooks Range, Campbell (1960) pointed out the almost complete lack of precise documentation of nests. A nest found in 1959 was in a cavity in a cliff face, and he draws attention to the fact that nests of this type would be much more difficult to detect than the normal large stick nests.

Haliaeetus leucocephalus. Bald Eagle. An adult was seen at the east end of the Atigun Canyon on 8 May 1970. This was probably a casual visitor from the south side of the Brooks Range, in which capacity it is recorded from Anaktuvuk Pass by Irving (1960).

Circus cyaneus. Marsh Hawk. An adult male was watched mobbing a Golden Eagle near the mouth of the Ribdon River on 5 June 1970. This species is probably only a straggler to the area. There are a few records listed by Irving (1960) for the Anaktuvuk Pass area, and Kessel and Cade (1958) give one record for the Colville River. West and White (1966), however, saw single pairs at Umiat on the Colville in the summers of 1964 and 1965, but there was no evidence of breeding.

Falco rusticolus. Gryfalcon. In 1969 there were four records of single birds in the Sagavanirktok Valley about 30 miles south of Franklin Bluffs; on 16 September one was seen just above the mouth of the Ivishak River, and on 21 September a pair was near the mouth of Accomplishment Creek. The 1970 breeding census showed a probable nest of this species near the west fork of the Atigun River, and an adult was seen in the vicinity. Two recently-fledged young were on a hillside near Galbraith Lake, and two probable nests were located in the area. A nest and two young on the wing nearby were seen near the Lupine River.

Falco peregrinus. Peregrine Falcon. This is a scarce breeding species in the study area. Nests containing two and three young, respectively, were found on Franklin Bluffs, and a non-breeding pair frequented cliffs on the west side of the Sagavanirktok Valley, about 48 km south of Franklin Bluffs, in 1970. It has been pointed out by Cade (1960) that this falcon has not been found nesting much above 610 m in Alaska. In fact the highest known nest at that time was 670 m on a tributary of the Sadlerochit River in June 1959. On this basis one would not expect to find any breeding pairs on the Atigun Valley or the upper reaches of the Sagavanirktok River.

Lagopus lagopus. Willow Ptarmigan. Widespread and common in the Sagavanirktok Valley, but apparently less numerous in the Atigun Valley, this species is found on low level tussock-heath tundra and in valley bottoms and grassy areas, particularly where it is damp and with plenty of dwarf *Salix*. Flocks began to form about mid-September, at which time they averaged up to 50+ in size. Larger flocks of 400+ were noted by late September. Flocks of up to 150 were seen in late April. While many of these ptarmigan leave the area in winter, it is clear from verbal reports received from oil industry personnel that some are present throughout the winter. The migratory nature of the Arctic Slope populations of the Willow Ptarmigan is discussed by Irving et al. (1967). The morphology of the Arctic Slope population of this species is dicussed by West et al. (1970).

Lagopus mutus. Rock Ptarmigan. This species appears to be less numerous than the preceding species and is found primarily on dry tundra in the foothills and mountains, generally from about 900 m upwards. I have not seen any large flocks of this species in the area, but this may be because I have spent insufficient time at suitable elevations.

Charadrius semipalmatus. Semipalmated Plover. This species was not seen at all in 1969 or 1971, and only twice in 1970. On 6 June one was seen near the mouth of the Lupine River, and on 21 June a pair was found in the Atigun Valley 14 km north of the west fork of the river. It is of interest to note that Kessel and Cade (1958) found this one of the commonest shorebirds along the Colville River, often closely associated with gravel constructions such as roads and airstrips. It remains to be seen whether developments of this nature in the Sagavanirktok and Atigun River Valleys result in an increase in this species in those areas.

Pluvialis dominica. American Golden Plover. This species is found during the breeding season scattered over tussock-heath tundra and also, less numerously, on montane tundra throughout the area from the Atigun and Sagavanirktok headwaters north to Franklin Bluffs. The density of pairs on territory proved to be somewhat variable. In the Atigun Valley eight pairs were located in 37 km of hiking. In the Sagavanirktok Valley between the mouth of the Atigun River and the mouth of Accomplishment Creek, the density worked out at two pairs per 5 km. In the Ribdon River Valley an area of about 10 square kilometers held five to six pairs, but in the Lupine River Valley a census area of about 3 square kilometers had no fewer than 10 pairs.

Capella gallinago. Common Snipe. This species is not common. Only one pair was located in the Atigun Valley between the west fork of the river and the western end of the Atigun Canyon; one was drumming on the east side of Galbraith Lake, one over a lake in the Ribdon Valley, one in the Lupine Valley, and one near Lake 730 in the Sagavanirktok Valley, all in June or July 1970.

Numenius phaeopus. Whimbrel. This species was recorded only in 1970 when a pair and a flock of six were seen in the Lupine River Valley near its junction with the Sagavanirktok River; the behavior of the pair suggested that they were breeding. According to Kessel and Cade (1958) this species is uncommon in the Colville Valley, although it is said to nest at the mouth of that river (Irving 1960).

Actitis macularia. Spotted Sandpiper. The only record is that of a pair seen displaying in the Atigun Canyon on 23 June 1970. Apparently this sandpiper does not breed in the Anaktuvuk Pass area (Irving 1960), but it is reported as being fairly common in the Colville Valley (Kessel and Cade 1958).

Heteroscelus incanum. Wandering Tattler. One was seen by a creek running into the Atigun River near the west end of the Atigun Canyon, on 2 July 1970 (Dr. J. Campbell, personal communication). It is quite likely that this species breeds in the Atigun Canyon and other suitable spots in this section of the Brooks Range foothills, as it does in the Anaktuvuk Pass area, but there is so far no proof that this is so.

Tringa flavipes. Lesser Yellowlegs. Recorded only on 26 July 1969 when one was seen about 48 km south of Franklin Bluffs, this wader would seem to have a limited distribution on the Arctic Slope. It is not mentioned by Bee (1958), or by Kessel and Cade (1958). West and White (1966), however, give details of its occurrence at Umiat on the Colville River in 1964 and 1965. It was classed by Irving (1960) as a conspicuous summer resident in the Anaktuvuk Pass area.

Calidris melanotos. Pectoral Sandpiper. In late July and early August 1969 a flock of 10 and two separate pairs were present in the vicinity of tundra lakes about 45 km south of Franklin Bluffs. In 1970 a pair was seen near the mouth of the Ribdon River in June, and another pair near the junction of the Atigun and Sagavanirktok Rivers. I have no records for the Atigun Valley. It appears to become more numerous towards the coastal areas.

Calidris bairdii. Baird's Sandpiper. This species appears to be sporadically distributed as a breeding species all along the Sagavanirktok River Valley from Franklin Bluffs southwards. It is less numerous in the Atigun Valley where, in June 1970, only two pairs were located in 14 km. Two breeding pairs and a flock of five were seen in the Ribdon Valley in late June 1970. Few records for the Colville River are given by Kessel and Cade (1958), and they do not mention breeding there. It breeds in the Anaktuvuk Pass area, often on dry areas at some height above the valley floor (Irving 1960).

Calidris minutilla. Least Sandpiper. On 29 June 1970, I located at least nine pairs on a census area of 10 square kilometers in the Ribdon River Valley, and also found one nest with eggs. The habitat was dry tussock-heath tundra ridges near a lake. There were at least six pairs in similar habitat in the Sagavanirktok Valley some 48 km south of Franklin Bluffs. The precise breeding distribution of this species on the Arctic Slope is not at all clear. Gabrielson and Lincoln (1959) give no breeding records. The species is not listed by Bee (1958), while Kessel and Cade (1958) give only one record for the Colville River. An adult male in breeding plumage was, however, collected near Umiat on 31 July 1964 and another was seen on 30 May 1965 (West and White 1966). At Anaktuvuk Pass, Irving (1960) gives no breeding records but mentions that many pass through to the north during the spring migration. Dr. Tom J. Cade informs me that he has found nests in the vicinity of Peters Lake and Lake Schrader, east of the Canning River.

Limnodromus scolopaceus. Long-billed Dowitcher. This species breeds in the Sagavanirktok Valley but is evidently scarce. On 24 June 1969 there were 12+ pairs (including at least one pair with young) on sedge-grass marsh about 48 km south of Franklin Bluffs. Only one pair was present in the same area in early July 1970, and two pairs in June 1971.

Micropalama himantopus. Stilt Sandpiper. Two were seen by the Sagavanirktok River about 72 km south of Franklin Bluffs on 9 June 1970. This appears to be a scarce species on the Arctic Slope and there is no evidence of breeding. It occurs on migration at Anaktuvuk Pass, along the Colville River and at Prudhoe Bay.

Calidris mauri. Western Sandpiper. A pair was seen in the Atigun River Valley on 20 June 1970, just south of the fork in the upper reaches. According to Gabrielson and Lincoln (1959) the only breeding records north of the Brooks Range would seem to be from Barrow and one or two places to the south along the coast. There do not seem to be any records from the Colville River or Anaktuvuk Pass.

Tryngites subruficollis. Buff-breasted Sandpiper. One by the Sagavanirktok River, just north of its junction with the Lupine River, on 9 June 1970 is the only record.

Limosa lapponica. Bar-tailed Godwit. One was seen feeding at the northern end of Galbraith Lake on 20 May 1970 (R. Anderson, personal communication). This godwit breeds along the west coast and in the Colville delta area, and has been noted on migration at Anaktuvuk Pass. The present record, which presumably refers to a migrant, appears to be its most easterly occurrence on the Arctic Slope to date.

Calidris alba. Sanderling. One seen by the Sagavanirktok River at Franklin Bluffs on 28 July 1969, was doubtless a vagrant from the breeding areas in Arctic Canada.

Phalaropus fulicarius. Red Phalarope. A pair on a pool by the Sagavanirktok River, just south of the mouth of the Lupine River on 9 June 1970, were doubtless moving north, as this is a coastal tundra-breeding species.

Phalaropus lobatus. Northern Phalarope. Two pairs on sedge-grass marsh about 45 km south of Franklin Bluffs in July 1969 had young; they were present in this locality again in 1970 and 1971. Pairs were recorded in 1970 also in the Lupine Valley, on a small lake at about 820 meters above sea level above the Atigun Canyon, and in the upper reaches of the Atigun Valley.

Stercorarius pomarinus. Pomarine Jaeger. Two at the north end of Franklin Bluffs on 31 July 1969 is the only record for the study area. This jaeger nests primarily on the coastal tundra.

Stercorarius parasiticus. Parasitic Jaeger. This species was not noted at all in 1969. A pair appeared at Galbraith Lake in the Atigun Valley on 19 June 1970 but did not stay to breed. A dark-phase bird was seen in the Lupine Valley daily from 30 June to 3 July. Up to three were seen on the tundra some 48 km south of Franklin Bluffs in early July 1970. I found no evidence of breeding, doubtless because of the low level of the microtine populations in the areas concerned.

Stercorarius longicaudus. Long-tailed Jaeger. Scattered pairs occur throughout the study area and undoubtedly breed in good lemming years. In 1970 pairs in the Lupine Valley were holding territory but were definitely not breeding. Instances of this species holding territory but not breeding because of the lack of lemmings has been recorded previously, as for example by Manniche (1910) and Maher (1964).

Larus hyperboreus. Glaucous Gull. Scattered breeding pairs and small flocks of non-breeding birds occur frequently in the valleys of the Sagavanirktok, Ivishak, Lupine, and Ribdon Rivers. I have no records from the Atigun Valley, although it no doubt occurs at least at Galbraith Lake on occasion. On 30 June 1970 two pairs, each with nests containing one egg, were found along a 3-km stretch of the Sagavanirktok River just south of the mouth of the Lupine River; on 3 July a further seven to eight nesting pairs were located along a 29-km stretch north of the mouth of the Lupine River. On 6 July four nesting pairs were found along 35 km of the Ivishak River. While this is primarily a coastal breeding species, it is clear that it also nests in the foothills of the Brooks Range north of the watershed. Irving (1960) classed it as a regular but uncommon breeding bird in the Anaktuvuk Pass area, and some instances of nesting in the upper reaches of the Colville River are given by Kessel and Cade (1958).

Larus canus. Mew Gull. This species was scarce in the area under discussion. On 29 July 1969 one was seen by Section Creek just off the Sagavanirktok River. A pair with nest and eggs was found at Galbraith Lake on 19 June 1970. Apart from the statement by Irving (1960) that they are common summer residents in the Anaktuvuk Valley where they nest, there seem to be no other records of breeding in the northern foothills of the Brooks Range. Non-breeding birds were reported from the Colville River by West and White (1966).

Xema sabini. Sabine's Gull. This is a coastal breeding species which may be seen inland on the Arctic Slope on occasions, although I have no records further south than Franklin Bluffs. One was seen over the Sagavanirktok River at the north end of the bluffs on 31 July 1969, and on 9 June 1970 a party of seven was seen in the same area.

Sterna paradisea. Arctic Tern. This tern is widely distributed in the Sagavanirktok Valley and its main tributaries, where it nests on gravel bars and on tussocks in sedge-grass marsh and similar habitats. No large colonies were found, the maximum numbers at any one locality being 8–10 pairs by a lake some 45 km south of Franklin Bluffs. I have no records for the Atigun Valley, but it is likely to occur there.

Nyctea scandiaca. Snowy Owl. When present this owl is most numerous on the coastal tundra outside the area covered by this paper. In 1969 a pair frequented the tundra about 48 km southeast of Franklin Bluffs, where they evidently had a nest, during late July and early August. On 17 September a total of four (including an adult with a juvenile) was noted just south of the bluffs, and on 19 September there were five between the bluffs and the White Hills. One was seen on the tundra between the Ivishak and Sagavanirktok Rivers on 23 October. An adult near Elusive Lake in the Ribdon River Valley on 11 May was the only 1970 record. It seems clear from the remarks of Campbell (1969) that the Snowy Owl is uncommon in summer in the Central Brooks Range and adjacent parts of the Arctic Slope.

Asio flammeus. Short-eared Owl. One was seen about 19 km south of the junction of the Ivishak and Sagavanirktok Rivers on 26 and 27 July 1969, and on 19 September a flock of 18 was found feeding on the remains of a caribou near a pingo just west of Franklin Bluffs, but only one remained by the next morning. The only 1970 record was of one south of the mouth of the Lupine River on 11 May. According to Gabrielson and Lincoln (1959), actual records of breeding on the Arctic Slope, other than in the Barrow area, are non-existent. Juveniles were taken on the Colville River in August 1953 (Kessel and Cade 1958). It is classed as fairly common in the Central Brooks Range and Arctic Slope by Campbell (1969), and his records include a family group at Little Chandler Lake in August 1967.

Colaptes auratus. Yellow-shafted Flicker. On 21 May 1970 one was seen near the eastern end of the Atigun Canyon (R. Anderson, personal communication). This woodpecker was recorded on the Colville River in 1937 (Kessel and Cade 1958) and in the Anaktuvuk Pass area in 1952 (Irving 1960).

Sayornis saya. Say's Phoebe. This species was found breeding in only one area. On 23 June 1970 a pair was carrying food or nesting material into a cavity about 1.5 m above the river in the Atigun Canyon. The next day a pair was noted at a nest on a ledge above a tributary of the Atigun River near the eastern end of the canyon. A circumstantial case of breeding on the Colville River is given by Kessel and Cade (1958), and West and White (1966) record three pairs (two of which were feeding young) near the junction of the Killik and Colville Rivers in July 1964. It seems probable that this phoebe has increased on the Arctic Slope since the early 1960's, since Cade and White (1973) record further instances of nesting in the Colville drainage area from 1967 onwards. They also state that in the Sagavanirktok River Valley in 1970 it was found nesting as far north as the Lupine River at 69°05′ N.

Eremophila alpestris. Horned Lark. This species does not seem to be particularly numerous and is confined in the breeding season to dry elevated areas in the northern foothills of the Brooks Range, usually above the 900-m contour. In June 1970, for instance, a total of four pairs was found in a 13-km stretch of the Atigun Valley immediately south of Galbraith Lake, and all were on dry hummocks where *Dryas* was the dominant vegetation.

Petrochelidon pyrrhonota. Cliff Swallow. On 24 June 1970 a colony of 7–10 pairs, together with a number of nests, were located by a tributary of the Atigun River in the Atigun Canyon at approximately 149°08′ W, 68°30′ N (Sage 1973). The only previously recorded breeding colony north of the Brooks Range was found on the Kuparuk River at the beginning of the century (Irving 1960).

Pica pica. Black-billed Magpie. One seen near the mouth of Accomplishment Creek in the Sagavanirktok Valley on 29 July 1970 by Dr. Clayton M. White, appears to be the first record of this species north of the Brooks Range.

Corvus corax. Common Raven. A widely distributed breeding species in the area under discussion, and quite numerous. A total of 11 was gathered at the remains of a caribou at Franklin Bluffs on 16 September 1969, and seven at the remains of another caribou in the same area on 8 May 1970. They habitually frequent the vicinity of camps on the Arctic Slope.

Turdus migratorius. Robin. A nest was found in the Atigun Canyon in July 1969, and a singing male was in the same area in June 1970. On 25 June 1970 one was heard singing in the Sagavanirktok Valley 5 km south of the mouth of Accomplishment Creek, and on 27 June another was singing about 1 km above the mouth of this creek.

Oenanthe oenanthe. Wheatear. This species is found on dry elevated areas in the foothills but does not appear to be common. Two pairs were located above the 900-m contour on the hills south of Section Creek on 29 July 1969. On 20 June 1970 two pairs were found at different points in the Atigun Valley. The habitat in both cases was dry hummocks dominated by *Dryas*.

Phylloscopus borealis. Arctic Warbler. This is a scarce species in the area studied, presumably because of the relative lack of *Salix* scrub of sufficient height. On 24 July 1970 a pair feeding four young in the nest was found by a small creek above the east side of the Sagavanirktok Valley about 48 km south of Franklin Bluffs, and on 5 July 1971 a pair with a nest was found about 3 km west of the previous site.

Motacilla flava. Yellow Wagtail. This species has been recorded in the Sagavanirktok Valley from Franklin Bluffs southwards towards the headwaters, and in most of the tributary valleys. I have no records from the Atigun Valley but it must occur there. It breeds along river and creek banks and by pools. In June 1970 there were 6+ pairs on a 10-k^2 census area in the Ribdon River Valley.

Anthus spinoletta. Water Pipit. An apparently uncommon breeding species of montane tundra and dry stony ground in the foothills, I have not encountered it below the 850-m contour.

Lanius excubitor. Northern Shrike.This shrike is associated with the riparian shrub habitat in valley bottoms, and while I have no actual evidence of its breeding in the Atigun or Sagavanirktok Valleys, it is likely that it does so. On 24 July 1969 a party of four juveniles was seen by a small creek above the east side of the Sagavanirktok Valley, not far south of the mouth of the Ivishak River. On 19 September an adult was noted near the mouth of the Lupine River. In 1970 I saw single adults in the Ivishak Valley on 5 June, in the Atigun Valley a few kilometers north of the west fork on 20 June, near the eastern end of the Atigun Canyon on 23 June, and near the mouth of Accomplishment Creek on 25 June.

Acanthis sp. Redpoll. Redpolls occur throughout the area under discussion from the upper reaches of the Atigun and Sagavanirktok Rivers, as far north as Franklin Bluffs. It is the second most abundant passerine and is associated with *Salix* and *Betula nana* scrub. The specific status of the redpolls occurring in the Atigun and Sagavanirktok Valleys and their tributaries cannot be settled in the absence of specimens for close examination. Two species are said to occur on the Arctic Slope, the Hoary Redpoll, *A. hornemanni* and the Common Redpoll, *A. flammea*. The former is considered the usual breeding species of the Arctic Slope, but Irving (1960) says that both species breed at Anaktuvuk Pass. The probability of hybridization cannot be ruled out.

Passerculus sandwichensis. Savannah Sparrow. Widely distributed but less numerous than the redpoll, it is found primarily in riparian dwarf scrub habitat, particularly along small creeks and around pools. I have found it as far north as Franklin Bluffs, where it frequented low *Salix* scrub with a ground flora of *Equisetum arvense* on gravel floodplains of the Sagavanirktok River.

Spizella arborea. Tree Sparrow. Its distribution and habitat are similar to that of the preceding species, and they are often found together. My impression in 1969 and 1970 was that this species was less numerous than the Savannah Sparrow. The highest elevation at which I have recorded this sparrow was just above the 700-m contour, where it was present in dense *Salix* scrub round a lake above Section Creek.

Zonotrichia leucophrys. White-crowned Sparrow. This sparrow occurs spasmodically along both the Atigun and Sagavanirktok Valleys and their tributaries, but appears to be less abundant than the two preceding species. It is restricted to fairly tall brush, and where suitable habitat exists may form what could almost be termed loose colonies. For example, just north of the junction of the Atigun and Sagavanirktok Rivers on 24 June 1970, at least six to eight pairs were found in well developed *Salix* along small drainage streams of the east side of the Sagavanirktok Valley between approximately the 600- and 850-m contours.

Calcarius lapponicus. Lapland Longspur. This is the commonest passerine and is widely distributed over the tussock-heath tundra.

Calcarius pictus. Smith's Longspur. Scattered nesting pairs of this species were found in the Atigun, Sagavanirktok, and Ribdon River Valleys in June 1970, a total of nine pairs being involved. It is clearly not a common species in the study area. My observations indicate that there is virtually no habitat overlap between the two species of longspur. The Lapland Longspur breeds on relatively dry tussock-heath tundra, while Smith's Longspur appears to be confined to level areas of sedge-grass marsh with scattered *Eriophorum* tussocks. The four nests found were all built into the side of such tussocks. The restriction of Smith's Longspur to relatively waterlogged areas of grassy tundra was also noted by Irving (1960) in Anaktuvuk Pass. Only one record for the Colville River is given by Kessel and Cade (1958). The distribution of this species in the northern foothills of the Brooks Range is very poorly known.

Plectrophenax nivalis. Snow Bunting. I have seen this species at only three localities in the foothills and never below 900 m. It is no doubt commoner than my records would suggest, but I have not spent sufficient time at the higher elevations to get a clear idea of its abundance. In the Anaktuvuk Pass area it was not seen at all in summer below about 1220 m (Irving 1960). This is in direct contrast to the situation further north on the Arctic Slope where it nests at sea level on the coastal tundra.

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Addendum

Megaceryle alcyon. Belted Kingfisher. Feathers of this species were found in a Peregrine Falcon eyrie on Franklin Bluffs in early July 1974 and were sent to me by Dr. Clayton M. White. This constitutes the first record of this species on the Arctic Slope of Alaska.

Winter Habitat of White-tailed Deer at Thirty-one Mile Lake, Quebec

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Huot, Jean. 1974. Winter habitat of white-tailed deer at Thirty-one Mile Lake, Quebec. Canadian Field-Naturalist 88: 293–301.

Abstract. A study of the winter habitat preferences of white-tailed deer (*Odocoileus virginianus borealis*) was conducted at the northern limit of the deer range in Quebec. Rates of use of various forest cover types, stand structures, topographical features, and browse species were estimated in a 50-square-mile deer wintering area. Intolerant mixedwoods appeared to be most important cover types for both browse production and occupancy by deer. White spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and eastern hemlock (*Tsuga canadensis*) were selected as shelter trees. Beaked hazelnut (*Corylus cornuta*) and mountain maple (*Acer spicatum*) supplied more than 50% of the winter food. Deer appeared to prefer stands offering dense clusters of mature conifers for bedding down, surrounded by brushy openings. These preferences appeared stronger as winter progressed and snow depths increased.

Introduction

This paper reports the relative importance of some vegetative and physical characteristics of winter deer habitat on the Thirty-one Mile Lake deer yard in Quebec. I evaluated the relative degree of use by deer of a variety of cover types, and produced a quantitative description of the forest characteristics of those cover types. The lack of quantitative information on deer winter habitat and the absence of methods for managing wintering areas was noted by Pimlott et al. (1968) during their investigation of the decline of deer in Quebec.

Study Area

The study area is a well known deer wintering area located near Maniwaki in Gatineau County, Quebec, about 90 miles northeast of Ottawa. Floristically the area belongs to a section of the Great Lakes - St. Lawrence forest region (Rowe 1959) and is characterized by the following tree species: sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), white pine (*Pinus Strobus*), and red pine (*Pinus resinosa*). The transition forest types of this region have been extensively described by Lafond and Ladouceur (1968), who noted an abundance of species, such as pines (*Pinus* spp.), usually present in more southern regions. The climax forest, the ''Erablière Laurentienne'' (*Aceretum saccharophori Laurentianum*) has been studied by Dansereau (1946), Grandtner (1962), and Lemieux (1963).

The area includes approximately 50 square miles of forest around Thirty-one Mile Lake. Altitude ranges from 500 to 1500 feet above sea level. The forest of the lowlands is composed of a multitude of conifer and intolerant mixed stands usually less than 100 acres, in which cedar is the most frequent occurring species, with balsam fir, white spruce, and white pine being well represented. Most of these stands, except the conifer swamps and some pure pine stands, are multiple-aged, and selective forest exploitation has been practiced for the last hundred years. The highlands are mainly covered with extensive stands of tolerant hardwoods dominated by sugar maple. Some hilltops are covered with red spruce, pine, and hemlock. The great variety of forest cover types and diversity of stand structures provided a good opportunity for studying the deer response to those characteristics.

Among the large mammals present in the area, white-tailed deer were the most common. The population of deer was estimated at 1500 to 1800 for the winter 1969–1970.

Mostly average climatic conditions prevailed during the two winters of the study, but snowfall was slightly below normal for both winters, highest accumulations being recorded in January 1970 (27 inches).

Methods

Distributions of deer were determined by observation from helicopter flights conducted in December, February, and March 1968–1969 and 1969–1970 (Figure 1). Deer densities by cover type were estimated in summer by the pellet-group count method (Bennett et al. 1940): 695 and 969 rectangular plots (1/50 acre) were sampled in 1969 and 1970, respectively. Quantitative estimates of the

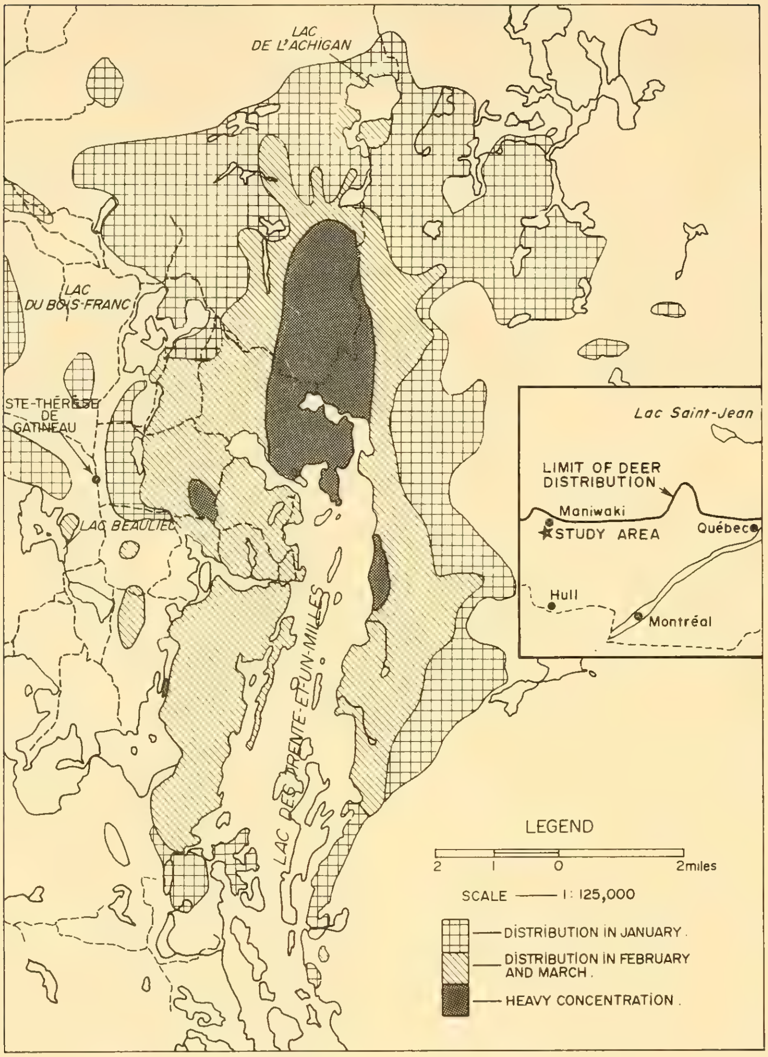

FIGURE 1. Thirty-one Mile Lake deer wintering area, Quebec.

availability, utilization, and preferences of browse species were obtained by the field method described by Passmore and Hepburn (1955). In the summer of 1969, 605 1/330-acre plots were sampled. These plots were located by drawing a series of parallel lines half a mile apart oriented east–west, at right angles to the slope. All living woody stems with twigs between 18 inches and 7 feet, originating within the plots, were recorded. The percentage of the twigs removed by deer was used as an estimate of browsing. A relative evaluation of the importance of each species was obtained by comparing the rate of browsing on a plant species with the availability of that species. The unit obtained is called a browse unit and is defined as the quantity of food taken when 1% of one stem is browsed by deer. This unit is not very accurate for comparisons between conifer and deciduous species, or stems of different size or for intensive studies, but has been used as a practical measure in extensive surveys (Passmore and Hepburn 1955; DesMeules 1965).

To determine the type of habitat preferred by deer at different periods, the relative area covered by each forest cover type was established for the over-

all deer distribution in December 1969 and March 1970. Shelter preferences of deer in winter were estimated from the location of their bedding sites (Gill 1961; Day 1963). The cover type, stand structure, snow depth, and percentage of conifer cover were recorded at each bed site. Totals of 181, 159, and 10 deer beds were located, and their shelter values measured during the last 15 days of January, February, and March 1970.

A classification of the forest cover types encountered in the area is given in Table 1. This classification takes into account the general characteristics of the forest in the area, the classification system of the Quebec Department of Lands and Forests, and the expected deer behavior with respect to the cover types.

Results and Discussion

Forest Cover Types and Deer Distribution

The areas occupied by deer at different periods in winter vary considerably in forest composition. In December, snow depths varied between 12 and 15 inches in the open, and stand utilization by deer appeared to be in proportion to their occurrence in the area. At this time, the area occupied by deer showed the following composition: pure tolerant hardwood stands covered 25% of the area, cedar–balsam–spruce stands 19%, mixed intolerant hardwoods 18%, mixed tolerant hardwoods 17%, pine stands 16%, conifer swamps 7%, and hemlock stands 4%. The area used by deer in March showed an increase in the proportion of cedar–balsam–spruce stands (26%), pine stands (25%), and mixed intolerant hardwood stands (23%). The tolerant hardwood stands and the mixed tolerant hardwood stands had decreased in importance while the conifer swamps and hemlock stands represented the same proportion of the area as in December. In the nucleus of the wintering area, cedar–balsam–spruce stands covered 48% of the area, the intolerant mixedwoods 18%, tolerant mixedwoods 11%, conifer swamps 8%, and the other types covered only 3% of the area (Figure 2).

TABLE 1 —Classification of forest cover types by stand composition

Stand type	Composition	Abbreviation
Forested upland conifer	Pine (white and red) > 50% of B.A.*	Pi
	Hemlock > 50% of B.A.	He
	Cedar, balsam fir, spruce > 75% of B.A.	CBS
Mixed	Conifer > 50% < 75% B.A.	
	Tolerant hardwoods**	CHt
	Intolerant hardwoods	CHi
	Hardwoods > 50% < 75% B.A.	
	Tolerant	HtC
	Intolerant	HiC
Hardwood	Tolerant hardwoods > 75% B.A.	Ht
	Intolerant hardwoods > 75% B.A.	Hi
Forested lowland	Conifer > 75% B.A.	Cs
	Mixed stands and hardwood stands	MHs
Open sites	Less than 10% cover	0

*B.A. = Basal area.
**Hardwood in this text means deciduous broadleaved trees.

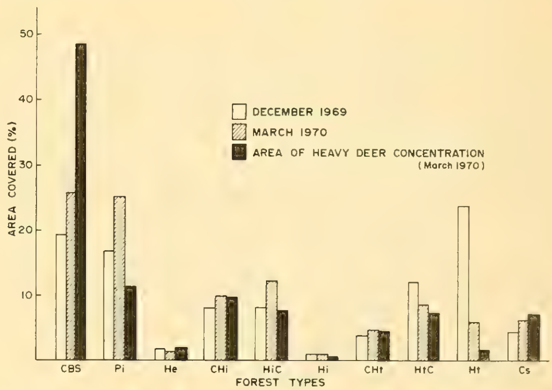

FIGURE 2. Forest composition of areas occupied by deer in December 1969 and March 1970, as indicated by the relative area covered by each important forest cover type (explanation of abbreviations in Table 1).

The average density of deer for all types was 37 ± 5 ($P < 0.1$) deer per square mile in 1968–1969 and increased to 43 ± 3 ($P < 0.1$) deer per square mile in 1969–1970. Four cover types were preferred by deer: conifer – intolerant hardwood, the cedar–balsam–spruce, the pine, and the intolerant hardwood conifer. The conifer swamps and the tolerant mixedwoods were much less important. Deer densities in the pure tolerant hardwood was only 5 to 8 deer per square mile (Figure 3).

Food Availability and Utilization

The estimation of food productivity by cover type shows that there exist important differences among types. The overall number of available stems per

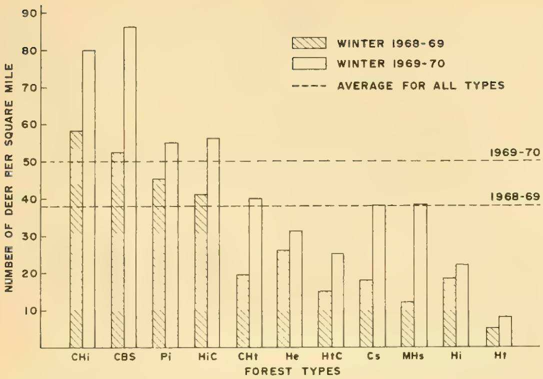

FIGURE 3. Density of deer in the 11 forest cover types as estimated by the pellet-group count (explanation of the abbreviations in Table 1).

acre was estimated at 6,560, the most abundant being hazelnut (*Corylus cornuta*), mountain maple (*Acer spicatum*), sugar maple (*Acer saccharum*), fly-honeysuckle (*Lonicera canadensis*), balsam fir (*Abies balsamea*), speckled alder (*Alnus rugosa*), and red maple (*Acer rubrum*), which accounted for 74% of all the browse-producing stems. The most productive forest cover types were the intolerant hardwood - conifer type, the cedar–balsam–spruce type, and the conifer - tolerant hardwood type. The least productive types were the conifer swamps, the hemlock stands, and the openings or abandoned fields (Table 2).

TABLE 2 — Food availability, utilization, and importance according to the cover types

Forest types	Stems per acre	Twigs browsed (%)	Browse units per acre
Intolerant hardwood conifer	7,970	26	207,200
Cedar–balsam–spruce	6,020	33	198,700
Conifer - tolerant hardwood	6,000	23	138,000
Conifer - intolerant hardwood	5,960	36	214,600
Pine	5,610	35	196,400
Mixed lowland types	5,580	13	72,540
Tolerant hardwood	5,290	10	52,900
Tolerant hardwood - conifer	4,710	23	108,300
Intolerant hardwood	4,350	26	113,100
Hemlock	4,270	24	102,500
Openings	3,630	51	185,100
Conifer swamps	2,970	17	80,500
All types	6,560	25	164,000

The general browse utilization was moderate (25% of the twigs) and permitted easy determination of specific preferences from the differential rate of utilization. Five species received 40% or more of browsing; these were dogwood (*Cornus stolonifera*) 51%, moosewood (*Viburnum alnifolium*) 49%, white birch (*Betula papyrifera*) 47%, white cedar (*Thuya occidentalis*) 44%, and red maple 40%. The species that were abundant but very lightly used were speckled alder (*Alnus rugosa*), ironwood (*Ostrya virginiana*), beech, and spruce (*Picea* spp.). As indicated in Table 3, two species account for 60% of the total number of browse units: beaked hazelnut and mountain maple. Bush-honeysuckle, sugar maple, and red maple account for another 14%.

The effect of browsing on the future production of food, as indicated by the percentage of stems mutilated or killed, was light in general. Only 2% of the stems were mutilated by overbrowsing and 1% were killed. Cedar was the most affected species, 25% of the stems of this species being mutilated and 37% killed. Dogwood was second with 15% of its stems mutilated and 5% killed.

Shelter Preferences

As indicated by the number of deer bedding sites found in each forest type, the preference for a protective cover structure increases as winter progresses (Table 4). Beds that were located within 15 feet of another bed were considered within the same bedding site. In January, 40% of the bedding sites contained only one bed, and the average number of beds per site was 2.9; in February, it decreased to 2.4 beds per site and in March to 1.3 beds per site.

TABLE 3 — The relationship between the availability of forage and the utilization and importance of those plant species in the diets of deer, winter 1968–69

Plant species	Availability,* %	Utilization,** %	Importance in diet,*** %
Corylus cornuta	32	51	34
Acer spicatum	19	49	26
Acer saccharum	8	12	4
Lonicera canadensis	6	25	6
Alnus rugosa	3	0	0
Acer rubrum	2	40	4

*Based on the number of stems per acre and the percentage of stems of each species.
**Based on the percentage of twigs browsed.
***Based on the relative number of browse units supplied by each species.

In January, only two cover types appeared to be preferred by deer for bedding; these were the cedar–balsam–spruce and conifer – tolerant hardwood types. During February, deer indicated a stronger preference for the conifer – intolerant hardwood type and abandoned the conifer swamps. Hemlock stands were only slightly represented in the sample but the presence of a concentration of 20 beds in a 1-acre stand suggests a strong preference for that cover type (Figure 4).

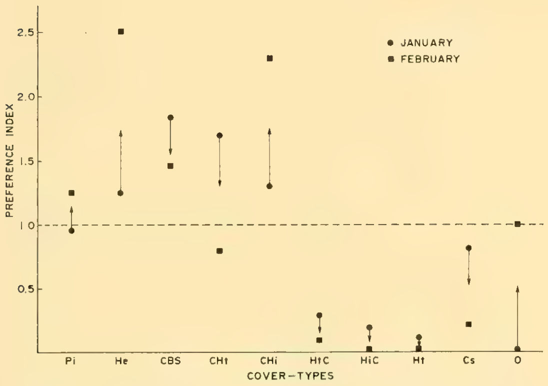

FIGURE 4. Preference index by forest cover types for deer bed sites in January and February 1970. Preference index = average number of beds per unit surveyed in a given type/average number of beds per unit surveyed in all types (explanation of abbreviations in Table 1).

At each deer bed, I recorded the size of the tree (> 4 inches D.B.H. (diameter at breast height)) nearest to the bed and its distance from the bed. In comparing the occurrence of the tree species in a random sample in the area with the occurrence of the tree species near the beds, a strong preference for conifer species is evident. Only 47% of the trees in the random sample were conifers while more than 90% of the trees nearest to deer beds were conifers. Among conifers, white spruce (*Picea glauca*) was most preferred in January and February; balsam fir was used in proportion to its frequency of occurrence during January but was selected for during February. Cedar was used slightly more than expected during January but less than expected during February. Deer appeared to avoid pine during both periods. There was no significant difference between the mean D.B.H. of trees nearest beds and of trees selected at random for any species ($.10 < P < .20$). The average diameter of nearest trees for cedar was 11.4 inches, balsam fir 7.9 inches, and white spruce 8.2. The average distance from the center of the beds to the nearest tree was 45 (standard deviation = 18.5) inches in January and 33 (standard deviation = 15.4) inches in February.

The basal area and standing volume of the different tree species were used as criteria to determine the composition of the stands where deer took shelter. The three most abundant tree species around the beds were cedar, balsam fir, and white spruce. During January deer occupied stands where 85% of the basal area and 92% of the volume of trees were in conifers; during February 86% of the basal area and 93% of the volume were in conifers.

The total number of living stems (1 inch or more D.B.H.) of balsam fir, white spruce, and aspen was least near the beds: February, 300 stems per acre; January, 476 stems per acre. The number of living stems larger than 4 inches D.B.H. and the volume of fir and spruce was greater near the beds than elsewhere. The mean diameter of balsam fir and white spruce was significantly larger near the beds ($P < .01$), and as snow depth increased from January to February deer chose to bed near significantly larger trees ($P < .01$). The sites chosen for bedding as winter progressed also showed a decrease in the number of cedar stems larger than 4 inches D.B.H. The estimated conifer cover at deer beds was 50% in January and 66% in the cedar–balsam–spruce type. Table 4 summarizes forest cover characteristics around deer beds.

Among the other environmental characteristics expected to influence the selection of bedding sites by deer, snow depth, topography, and exposure were considered. Deer tended to bed in areas of lesser snow depths during the whole period of the study. During January, the average snow depth at bedding sites was 9.6 ± 2.10 inches as opposed to 10.8 ± 2.31 inches in conifer stands in general, and in February the average snow depth around the beds was 15.8 ± 2.72 as opposed to 24.5 ± 4.19 inches under conifer stands; the difference was highly significant in February ($P < .01$), but non-significant in January. Snow depths in the openings varied from an average of 16.9 ± 2.60 inches in January to 29.8 ± 3.10 inches in February.

Recent clearcut areas, 2 to 3 years old, appeared to offer particularly adverse conditions as snow accumulated on the debris. Although some small shelter stands had been left after logging, deer did not stay in these areas. Snow depths in February, in

TABLE 4 — Forest characteristics around deer beds in January and February 1969

Period	Preferred types	Conifer cover (%)	Volume of spruce, fir, and cedar (cubic feet)		Mean D.B.H., spruce and fir (inches ± s.d.)		Number of stems per acre, spruce and fir (> 4″ D.B.H.)	
	CBS	50	Spruce	207	Spruce	4.0±2.40	Spruce	46
January	CHt		Fir	246				
			Cedar	745	Fir	3.2±2.40	Fir	55
			Total	1198			Total	100
	CBS		Spruce	253				
February	He	66	Fir	376	Spruce	5.5±2.29	Spruce	55
			Cedar	546	Fir	5.6±1.92	Fir	82
			Total	1175			Total	137

the openings created by 2-year-old logging operations averaged 35.7 inches as opposed to 29.8 inches in the adjacent fields. Deer were observed to use intensively areas where logging operations were under way, but deserted these sites most of the time a few weeks after the cessation of the exploitations.

With respect to topography, deer selected small flat elevations. Sixty-five percent of the beds were located on elevations, 25% on slopes (20% or steeper), and 10% in depressions. Deer did not show any exposure preference during January, but in February they avoided bedding on north and northeast slopes and concentrated on southwesterly exposed slopes. The effect of topography is also evident when one compares the density of deer in the cedar–balsam–spruce type (65 deer per square mile) near the lake to the density on the top of the mountain (5 deer per square mile). Although the shelter quality of the stands and the food availability in each area were similar, deer did not stay at high altitudes after January but occupied stands in the lowlands. The amount of snow on the ground on the top of the mountain was greater and the winds probably stronger, and these combined to force deer to move into more comfortable areas.

Habitat Preferences

In the lowlands, the relative quantity of food available and the shelter quality of the stands both played a more important role in the distribution of deer. In Figures 5 and 6, the data on food availability and conifer abundance are related to the quantity of food taken by deer and the number of beds found. In Figure 5, each type has been classified on the basis of the volume of conifer trees (> 4 inches D.B.H.) per acre and the number of stems available as food. Figure 6 summarizes the relation existing between the food utilized and the number of beds found per chain surveyed in each type. If Figure 5 is divided with a vertical line, the forest types on the right side have a better-than-average shelter potential and those on the left a lower-than-average potential. The central points represent the median of each parameter and closely correspond to the mean. The horizontal central line divides the types with a better browse supply from those with poor food potential. Cover types in the upper right quadrant (pine, conifer – intolerant hardwood, and cedar–balsam–spruce) are potentially good for shelter and food supply. The types in the lower left (tolerant and intolerant hardwoods and tolerant hardwood – conifer) have poor food and shelter potential. The types on the lower right part (hemlock and conifer swamp) should normally have a good shelter potential but be poor in food supply, whereas the types at the upper left (mixed lowland types, conifer – tolerant hardwood, intolerant hardwood – conifer) have a good food potential but poor shelter. The diagonal lines divide the types into three groups on the basis of their general potential (food and shelter combined) as deer winter habitat. The intolerant mixedwoods, the cedar–balsam–spruce, and pine types have a better-than-average potential, whereas the mixed lowland, conifer – tolerant hardwood and hemlock types, intolerant hardwood types and conifer swamps have low deer habitat potential in winter. Stands with more than 1000 cubic feet of conifer per acre are

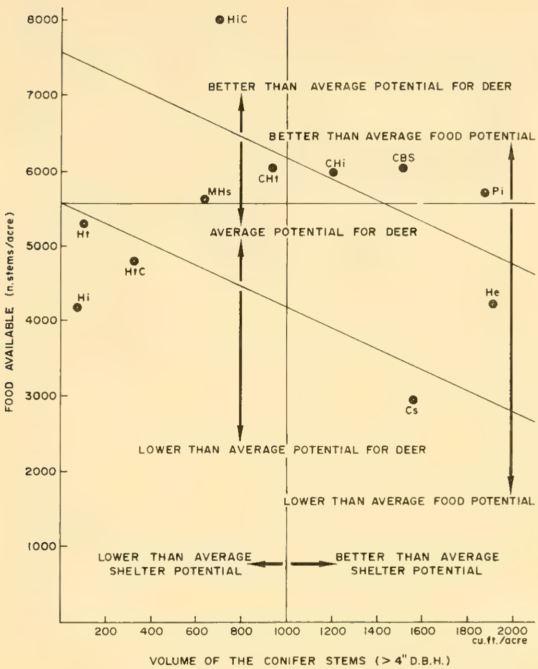

FIGURE 5. Food and shelter potential of forest cover types for deer (see text).

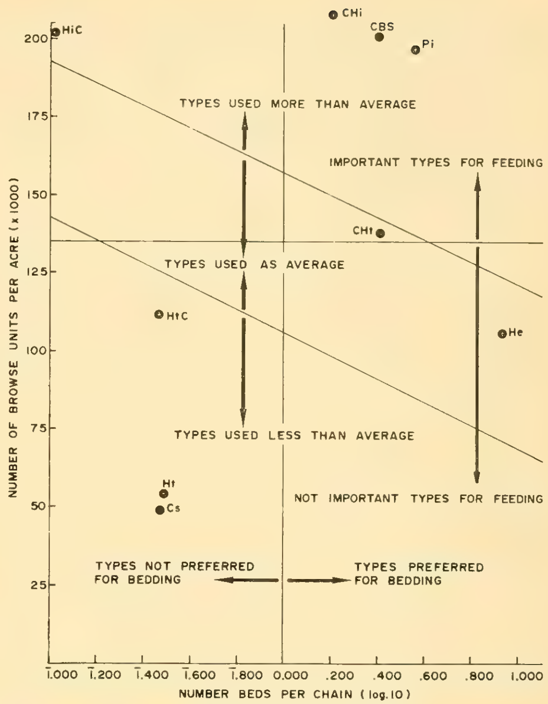

FIGURE 6. Selection of forest cover types for bedding and feeding by deer (see text).

considered as potentially good for shelter. The quality of the shelter is better when a greater part of the volume is in spruce and fir, especially when the mean D.B.H. is over 5 inches.

In Figure 6, the relative use made by deer of the food and shelter in each type is illustrated. The number of browse units per acre was considered as an index of the relative quantity of food taken in each type, while the relative preference for a cover type because of its shelter was evaluated by the $\log^{10}$ of the number of deer beds found per chain in each type during the winter survey. The same divisions as in the previous figure have been used. In the upper right quadrant, the forest types which occur are the conifer – intolerant hardwood, cedar–balsam–spruce, pine and conifer – tolerant hardwood types; these types were used mostly for feeding. In the lower left quadrant, the types which occur are the tolerant hardwood – conifer and tolerant hardwood types and the conifer swamps; these were not used very much for either feeding or bedding. In the lower right quadrant, one type (hemlock) was used by deer as cover but did not supply any food. The types that were generally used are, intolerant mixedwoods, cedar–balsam–spruce, and pine types and the openings. Two types which were moderately used are hemlock and conifer – tolerant hardwood. Three types, tolerant hardwood – conifer, tolerant hardwood, and the conifer swamps, were used less than average.

The strong relationship which exists between the potential of the types and their use is evidenced by the fact that most of them are found in the same quadrant on both Figures 5 and 6. Only two types, the openings and the conifer swamps, occupy appreciably different positions in the two figures. The lowland conifer type is used less than expected on the basis of its potential shelter quality. The proportion of balsam fir and spruce in these stands, however, is very low and this may lower the shelter potential. Moreover, the location of these stands with respect to topographic features makes them less attractive to deer, which prefer to bed on high spots. Deer used openings more than expected for feeding and bedding. The supporting quality of the snow in the fields is often better than in the forest

because wind action packs the snow and improves walking conditions for deer. Bedding in the openings also allows deer to take advantage of direct sunlight.

The literature on winter behavior and winter habitat of deer in the northeast is abundant, but most authors report that deer seek areas offering the maximum of physical comfort rather than any other benefit (Banasiak 1961; Dahlberg and Guettinger 1956; Severinghaus 1953; Telfer 1967). Ozoga and Gysel (1972) report that low temperatures or high air chill force deer to move into dense conifer swamps in Michigan, even if snow depths are not prohibitive to deer movements elsewhere.

In the present study, it appears that deer preferred the semi-open forest, which could be the best compromise under Quebec conditions. Stands that were used had a conifer cover between 40% and 66% in general, and a total cover between 50% and 70%. The total basal area in cover types used for bedding in January averaged 99 square feet and in February 90 square feet, which is slightly lower than the 120 square feet reported by Telfer (1968) for shelter types. The distribution of the stems within these stands, however, offered dense coniferous clusters where deer bedded most of the time, and small brushy openings (created by selective cuttings or spruce budworm (*Choristoneura fumiferana*) epidemics) where deer foraged. The fields, lakes, and hardwoods were used only slightly by deer between late December and the end of March. Deer used the fields only when crusts formed at night or early in the morning; however, the quantity and quality of food in these areas is certainly less than in agricultural habitats of western Minnesota, as reported by Moen (1968).

The increase in the use of southwest slopes in February is interpreted as a move toward a warmer microclimate, as observed by Telfer (1967). These slopes have higher daily maximum and minimum temperatures, as reported by Geiger (1965, pp. 425–426). Deer could also take advantage of the warming effect of adjacent small clearings where they foraged. These clearings exhibited the same characteristics as of small circular clearings where Geiger (1965, pp. 351–352) reported wind protection and even temperatures. At the northern fringe of its distribution in Quebec, deer could probably not maintain positive energy budgets during the winter in fields or in hardwood forest, and therefore sought semi-open stands, southwest exposures, and sites of least snow depths. Extensive mature softwood stands, such as cedar swamps, were also only occasionally visited because of the absence of available forage.

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Investigations of Mallards Overwintering at Calgary, Alberta

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Abstract. Mallards (*Anas platyrhynchos*) were investigated intermittently from 1957 through 1967 to determine why they failed to migrate, and to test methods for controlling their numbers which increased from 2,000 in the early 1950's to a peak of 14,000 in 1964–1965. Band returns showed that most Mallards originated from breeding grounds north of Calgary and most returned there the following spring. More than one half of the direct band recoveries from Mallards transferred from Calgary to coastal British Columbia were made in Alberta and a significant fraction of survivors returned to Calgary the next winter. Data are given on sex and age ratios, weight trends, and the incidence of shot wounds. Available food, open water, and protection from hunting were considered the main factors causing Mallards to forego migration. Of the control methods tried (no supplementary feeding, removal by transfer, scaring with acetylene exploders, and winter shooting within the city), cessation of feeding was the most acceptable and efficient way to reduce numbers.

Introduction

Each year flocks of Mallards (*Anas platyrhynchos*) attempt to overwinter at various places in southern Alberta. These places feature open water and a nearby source of food, harvested grain fields usually. Depending on weather conditions, many of these ducks apparently survive. Although the overwintering flocks form a minor part of the provincial or flyway Mallard populations, they do create special public-relations and management problems, particularly those wintering close to population centers, airfields, etc.

The largest and most persistent flock has wintered on the Bow River at Calgary (51° N, 114° W). The Bow River, which flows through the city, never completely freezes because of industrial and domestic sewage entering it there. Protection from hunting within the city and a feeding program by the Alberta Fish and Game Association also induced Mallards to winter at Calgary. Stockyards in the city and grain fields nearby also provided food.

This paper describes results of various investigations of the Calgary flock from 1957 through 1967. Objectives were to determine factors responsible for the flock build-up and to recommend control methods. Later, data were collected during control efforts. RDH banded 698 Mallards during two winters, 1957–1959. LGS banded 2,441 in two winters, 1963–1965, and weighed and fluoroscoped samples. That project was halted prematurely because of the urgency to reduce the flock. During the 1965–1966 winter, WJT took part in a cooperative scare program, and eventually trapped and transferred 1,262 Mallards to British Columbia. The following winter, KV collected data on 506 ducks shot during a control experiment.

The Study Area

The two main areas used by Mallards were the Inglewood Bird Sanctuary and an area near the Consolidated Mining and Smelting Company's (Cominco) fertilizer plant (Figure 1). At Inglewood, the ducks used a 2-acre pond most of the time, as it contained the main feeding station. When the pond froze during prolonged sub-zero weather, they used the Bow River and a small sewer discharge stream that entered the river on the sanctuary. Warm water flowed through a large ditch from the Cominco plant to the river, providing open water at all temperatures. Feed was also distributed here. Depending on snow conditions, Mallards fed in harvested grain fields northeast of the sanctuary (Figure 1).

Climate at Calgary is classed as "cold temperate" but is modified most winters by chinook winds from the Rocky Mountains (Anonymous 1959). This feature results in variable temperatures. The normal winter mean temperature at Calgary Municipal Airport (3,540 feet elevation) is 17°F while extreme means of 4°F and 32°F have been

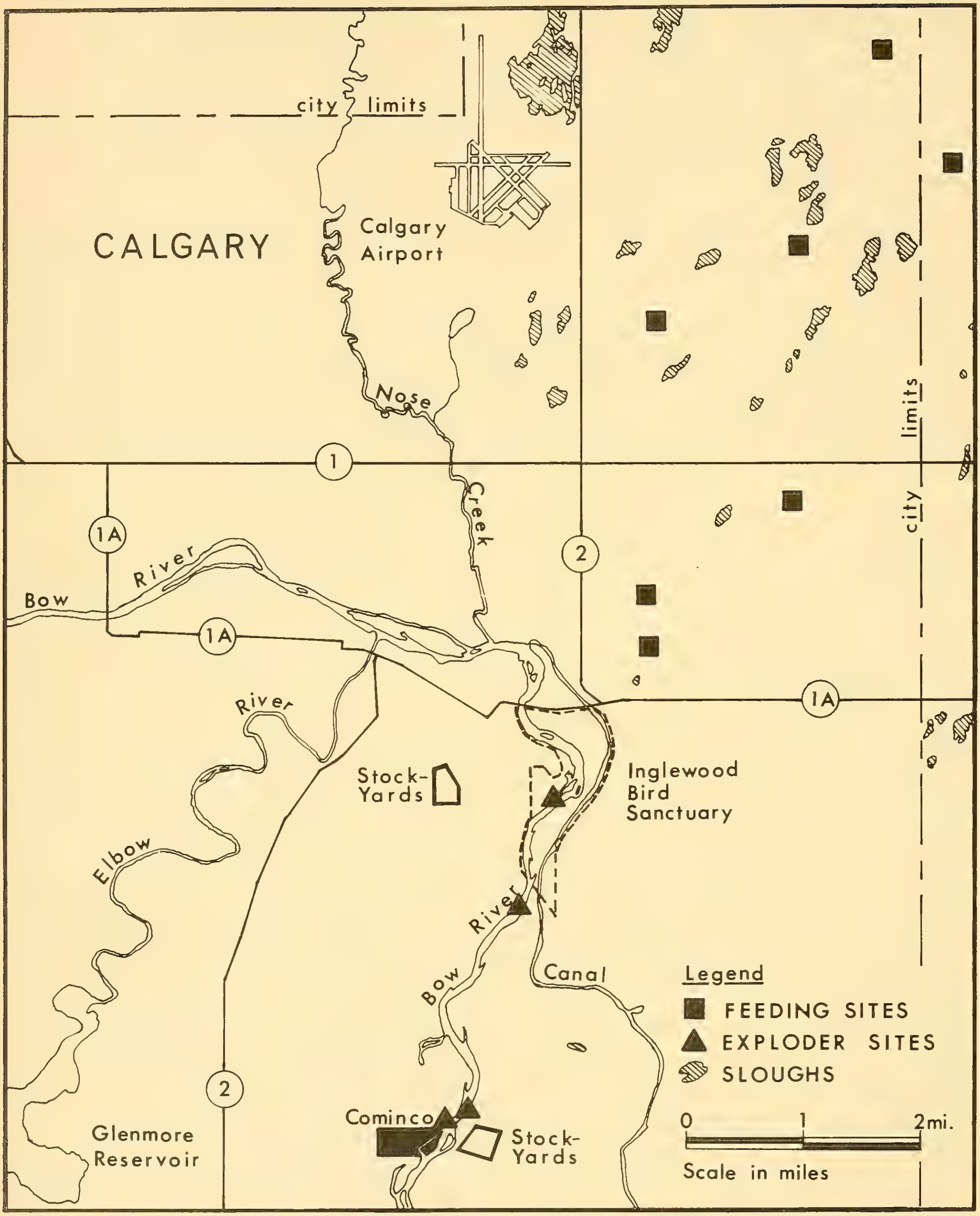

FIGURE 1. Map of study area.

recorded. Extreme high and low temperatures prevailed during the winters of 1963–1964 and 1964–1965, respectively. The mean minimum temperature for the months of December, January, and February was 12.2°F in 1963–1964 and −1.3°F in 1964–1965. The long-term average was 6.7°F. Snow depth at Calgary seldom exceeds 12 inches. In 1963–1964 maximum depth at the airport was 6 inches; in 1964–1965 it was 9 inches.

Methods

Estimates of flock size were obtained by ground counts, aerial counts, and use of the Lincoln Index (Adams 1951). Mallards were captured in bait traps on land and with cannon projectile net traps on ice and land. Traps were baited with barley or wheat. The optimum temperature range for trapping appeared to be −10°F to 10°F. Below that, ducks were reluctant to leave the water. Pulliainen (1963) described similar behavior. At higher temperatures, Mallards at Calgary tended to disperse along the river, and few were attracted to the bait. When bait-trapping in 1964–1965 became unproductive, we set a cannon net, 25 × 75 feet, on the pond ice. The ice was chopped out to receive the recoil blocks and launching rods. At Cominco the net was set on an unused road that served as a feeding station. Because the ground was frozen, cannons were mounted on concrete recoil blocks that also served as anchors for the trailing edge of the net.

All Mallards were banded; samples were weighed to the nearest 10 grams; some were also fluoroscoped with an apparatus similar to the unit described by Elder (1955). Samples of drakes were aged (Hochbaum 1942) during the first visits of the 1963–1964 and 1964–1965 winters.

Results and Discussion

Flock Size

Mallards overwintering at Calgary numbered about 2,000 in the early 1950's and reached a peak of 14,000 in 1964–1965. In October 1965 there were about 12,000 present, but by January 1966, only 3,500 remained. Similarly, 12,000 were estimated the next fall, but the number remaining in January was about 4,000. Since then the number has fluctuated but never exceeded 4,000. The effect of the control program started in 1965–1966 is discussed later.

Migration

Mild fall weather delays Mallard migrations from the southern Canadian prairies (Low 1957), and reports of wintering flocks in Alberta are more prevalent in such years. Although most migrants have left the province by early December, later flights sometimes occur. To illustrate, in late December 1969, over 200,000 Mallards were concentrated on two lakes and the Bow River about 30 miles east of Calgary (G. Freeman, personal communication). Most left on 3 January and an estimated 36,000 were present on 8 January. Most of these left soon after. An exceptionally late grain harvest, coupled with light snow cover, contributed to the delayed migration.

Most Alberta breeding areas probably contribute Mallards that winter at Calgary, though those north of Calgary apparently contribute a majority. This conclusion is based on the banding locations of birds recovered within 12 miles of Calgary during November and December of the banding year, and the distribution of direct recoveries in autumn of Mallards banded at Calgary in winter. Some originate in western Saskatchewan, as evinced from one banded 27 July at 51°40′ N, 110°00′ W and retrapped the following winter at Calgary. Another banded at 51°20′ N, 109°20′ W on 16 August was shot at Calgary on 6 December. A few may undergo a reverse fall migration (Mann 1950) and attempt to winter in Alberta. One banded 9 September in Montana was retrapped that winter in Calgary 335 miles NW of its banding site. Another banded in Washington (46°10′ N, 118°50′ W) in August was shot near Calgary the following October.

That a substantial portion of surviving Mallards returned to winter at Calgary is suggested by the relatively large number of late-season direct and indirect recoveries made in the vicinity. More conclusive evidence is the number of banded birds retrapped the next winter. Of 1,844 trapped in 1964–1965, 3.6% were from the 695 banded there the previous winter. Using our most conservative estimates of flock size and survival rate, we estimate that a majority of 1963–1964 survivors (perhaps as high as 80%) returned the next winter. The estimate is supported by the low proportion of direct recoveries (31%) made in the United States. This is in contrast to 77% direct recoveries occurring in the United States for adult males banded elsewhere in southwestern Alberta (Anderson and Henny 1972).

During late winter, Mallards tended to disperse along the Bow River, then ice-free, southeast of Calgary. Distribution of direct fall recoveries simply shows that many Mallards were shot north of Calgary—some as much as 200 miles—suggesting a northward spring migration, though northward shifts in late summer and early fall cannot be discounted. Eleven spring and early summer direct recoveries, however, clearly indicate a northward dispersal. All of them were made north of Calgary and distances ranged from 190 to 620 miles. The fact that there were no similar recoveries for the more densely settled southern areas supports our contention that most Mallards migrate north from Calgary in spring.

Dispersal of Displaced Mallards

In January and February 1966, 881 male and 381 female Mallards were trapped at Calgary, air-freighted to Vancouver, British Columbia, banded, and released near the mouth of the Fraser River. During the 1966 hunting season, 66 banded birds were recovered in Canada; 37 of these came from Alberta and 29 from British Columbia. Because of differences in hunting effort it is impossible to make a quantitative comparison of recovery rates for the two provinces. It is clear, however, that a substantial portion of the ducks returned to Alberta, and most of these appear to have returned to the Calgary area.

In addition to the direct recoveries mentioned above, 13 were made by the control team at Calgary during the 1966–1967 winter. These comprised 2.6% of the shot sample of 506 ducks. This can be projected to provide a crude estimate of the proportion of survivors that returned to winter at Calgary. Assuming a flock size of 4,000 during the collecting period and 50% survival for the 1,262 displaced Mallards, then about 104, or 16%, of the survivors returned. More may have stayed had there been no scare program that winter.

The return to Alberta is not surprising in view of Munro's (1943) recoveries from 16,789 fall- and winter-banded Mallards on the coastal plain of British Columbia from 1938 through 1940. A small but consistent number was recovered in Alberta, mainly in the Peace River and central areas. Our displaced Mallards that crossed the Continental Divide would probably migrate south along traditional routes east of the mountains rather than return to coastal British Columbia. Evidence that this would happen is provided by Bellrose (1958) who reported on movements of drake Mallards transferred in November from Illinois in the Mississippi Flyway to Utah in the Pacific Flyway. Recoveries made the next fall showed that about two-thirds of the adults returned to the Mississippi Flyway. Bellrose (1958) believed the ducks migrated north in spring, probably with Pacific Flyway ducks, to Alberta and Saskatchewan breeding grounds. Here, if not already on familiar terrain, they were close to it and many were able to return to their original flyway.

Since our recoveries tended to be concentrated near the British Columbia release site or near Calgary, there is no definite pattern indicating the route taken by returning ducks. Munro's (1943) data indicated that Mallards wintering on the coastal plain reached Alberta by crossing the mountains in the Peace River area. Eight of our recoveries support this route; none discount it.

Proportionately more females than males were shot in British Columbia, suggesting that females showed less tendency to disperse to former migration routes. These percentages (52% vs. 33%) are not significantly different ($P > 0.1$) for the smaller sample of first-year recoveries but are for total recoveries (55% vs. 30%; $P < 0.01$). This difference also could be due to differences between sexes in vulnerability to hunting.

Sex Ratios

A striking feature of Mallard flocks that overwinter in Alberta is the preponderance of males, which may exceed 70%. Because of bias associated with bait traps (Bellrose et al. 1961), our percentage of drakes in bait-trap samples (Table 1) may be too high. They were significantly higher ($P < 0.05$) than percentages of drakes taken in net traps in the same winter. We believe the latter gave the more reliable estimate. The sample of shot

TABLE 1 — Percentage of drakes in Mallards examined at Calgary

Winter	Number examined	Percent drakes
1957–1958	620[a]	75.3
1958–1959	89[a]	78.7
1963–1964	697[a]	75.8
1964–1965	1,247[a]	74.7
1964–1965	611[b]	69.9
1965–1966	1,268[b]	69.8
1966–1967	506[c]	71.8

[a]Bait trap.
[b]Cannon net trap.
[c]Shot by control team.

ducks in 1966–1967 is believed free of bias because shooters did not select either sex.

Pulliainen (1963) observed that winter Mallard flocks in Finland were male-predominant. The 10-year average for one flock was 58%. He suggested the unbalanced sex ratio resulted from higher hen mortality and greater tendency for hens to migrate. Composition of wintering flocks apparently reflects that of late migrants and since the latter are male-predominant (Gollop 1965), the observed sex ratios are to be expected. Gollop (1965) had significantly more direct male than female recoveries north of his Kindersley, Saskatchewan (51° N, 109° W) banding block. Such dispersal would contribute to the unbalanced sex ratio in late fall.

Age Ratios

Our ratios indicate considerable year-to-year variation in the proportion of immatures (birds hatched the preceding summer) in the flock. A sample of 95 drakes aged in early January 1964 showed 63% immatures. That ratio is probably low because some immature drakes may assume adult characters as early as mid-November (Hochbaum 1942). The next winter, 151 drakes were aged 5 to 6 weeks earlier, but the indicated immature portion was only 12%. Assuming 67% immatures in 1963–1964, the immature/adult ratio dropped 93% between winters. Based on wing samples, Smart (1966) reported declines in immature/adult ratios from 1963 to 1964 in the Central and Pacific Flyways of 37% and 27%, respectively. Although this would account for some of the observed decline at Calgary, it is unlikely that it was the sole reason. The mild fall weather in 1963 in contrast to 1964 may have caused a greater proportion of immatures to remain.

Mallard Weights

Mean weights of Mallards declined during winter (Table 2), and though some declines were significant none was serious. Decreases in mean weights did not exceed 16%, indicating that most of the birds wintered well. This was true whether or not they were fed.

The coefficient of variation was significantly lower ($P < 0.01$) in samples of shot ducks than in trapped ducks, indicating a more uniform sample in the former. Absent from the shot samples were ducks of extremely low weight that occurred in trap samples. Such birds would be relatively sedentary and less likely to be shot.

During late winter virtually all female Mallards were paired and on mild days, considerable courtship activity was evident. There was nothing to suggest that the birds were anything but normal.

Winter Mortality

Banded samples suitable for calculating mortality rates are limited as a result of effects of the control program after banding. Hickey (1952) showed there was some correlation between direct recovery and mortality rates, and Martinson (1966) developed a regression equation for this relationship based on post-season male Mallard bandings at United States wintering areas. For a sample of 525 drakes banded at Calgary in 1958 and 1959,

TABLE 2 — Mean weight of Mallards, in grams, with two standard deviations. Figure in brackets after weights represents number of ducks weighed.

Date		Weight: Females	Weight: Males
7–9	Jan. 1964	1,077±243 (28)	1,226±206 (95)
27–30	Jan. 1964	1,066±187 (114)	1,229±210 (291)
24, 25	Feb. 1964	1,035±180 (27)	1,167±169 (136)
30 Nov. - 3 Dec. 1964		1,023±185 (138)	1,198±183 (160)
5–8	Jan. 1965	1,022±236 (84)	1,228±219 (167)
11	Feb. 1965	952±154 (56)	
17, 18	Mar. 1965	973±157 (68)	1,128±162 (155)
1, 2	Feb. 1966	1,081±185 (45)	1,206±190 (112)
10	Nov. 1966	1,218±92 (12)	1,339±92 (48)
6, 7	Dec. 1966	1,061±68 (65)	1,224±75 (137)
4	Jan. 1967	1,104±66 (23)	1,250±86 (60)
30, 31	Jan. 1967	1,026±39 (21)	1,170±74 (38)
6, 7	Mar. 1967	1,029±55 (22)	1,209±71 (80)

the calculated mortality rate was 47% (Lauckhart 1956) and the direct recovery rate, 5.3%. Based on this recovery rate, Martinson's (1966) regression predicts a mortality rate of 36%. The difference indicates that non-hunting mortality may have been comparatively high in our Mallards. When the climatic differences between Calgary and United States wintering areas are considered, this is a reasonable expectation.

If samples of ducks are banded during different periods of a given winter, differences in survival among samples should be reflected in subsequent band recovery rates, or retrap rates in later winters. This assumes the only variable is survival rate between banding periods, and all ducks surviving the banding winter have equal chances of being either shot and reported or retrapped. Banding spanned only a 7-week period in 1963–1964, so little or no difference in survival could be expected, as was the case (Table 3). The next winter, there was no significant difference in survival indexes among samples banded from early December through to mid-March. We could detect no mortality over the 3½-month period by this means. Some mortality did occur, however, as evinced by dead ducks we found each visit. It appeared there was a consistent but small loss of ducks that became too weak to obtain food.

Incidence of Shot Wounds

One popular reason for the failure of Mallards to migrate was that the ducks were wounded. To check this, we fluoroscoped 488 live Mallards and 34 found dead in 1964–1965. Close to 90% of the drakes had survived at least two hunting seasons. Most Mallards were not wounded (Table 4), and the incidence of shot wounds was probably close to that of birds that migrate from the area. Similar percentages have been found for migratory Mallards elsewhere (Elder 1950, 1955; Bellerose 1953). The lower incidence in females reflects their smaller size (Elder 1955).

In a sample of Mallards fluoroscoped and weighed 30 November–3 December, wounded males averaged 38 grams lighter than shot-free males ($P < 0.02$); wounded females averaged 50 grams less than shot-free females ($P < 0.01$). It appeared that only a few of the wounded birds were seriously affected and their low weight depressed the mean. If trapping favored stronger birds, the difference between mean weights in the population may have been greater than indicated. Bellerose (1953) however, found no difference in mean weights between much larger samples of wounded and shot-free Mallards trapped in Illinois. He noted there was an unknown loss that occurred between the time ducks were hit, but continued in flight and migration, and the time they were live-trapped. We believe our sample included at least part of this "loss" and it was represented by ducks in such poor condition that they would fail to migrate and would not be available for live-trapping farther south. If the weight below which Mallards would not migrate is arbitrarily set at 900 grams for females and 1,070 grams for males, 16% of the females and 15% of the drakes were in that category of wounded birds. Corresponding ratios for shot-free ducks were 5% and 9% for females and males, respectively. The relationship holds regardless of level set for critical weight. This difference indicates that failure to migrate because of shot wounds could account for little more than 2% of the total flock.

TABLE 3 — Percentage of combined reported bands and retrapped Mallards from different banding periods

Banding period		Number with bands[a]	Percent of bands reported and Mallards retrapped[b]
7–9	Jan. 1964	123	26.8
27–30	Jan. 1964	417	23.5
24–25	Feb. 1964	155	25.8
30 Nov. – 3 Dec. 1964		530[c]	20.7
17–19	Dec. 1964	304	17.1
5–7	Jan. 1965	343	18.4
8–11	Feb. 1965	460	18.3
17–18	Mar. 1965	181	16.0

[a]1964–1965 samples include 1963–1964 ducks retrapped at Calgary.
[b]If a retrapped duck was later shot and reported, it was counted only once.
[c]513 newly banded; 6 shot and reported same season; we arbitrarily assume 7 were shot and not reported; hence 500 plus 30 1963–1964 retraps gives sample of 530.

TABLE 4 — Incidence of shot wounds in Mallards

Sex	Numbers with 0 to 6 pellets[a] 0	1	2	3	4	5	6	Percent with shot
Male	176	39	16	4	5	2	1	27.6
Female	189	39	10	5	2	0	0	22.9
Totals	365	78	26	9	7	2	1	25.2

[a]None with more than six pellets.

Based on band recoveries, there was little or no difference in survival between Mallards with and without shot wounds. Accumulative band recovery rate for 120 that carried shot was 12.5% compared with 14.0% for 357 shot-free ducks. Including retraps the resulting indexes were 18.2% for wounded birds and 21.8% for shot-free birds, the difference not being significant. Samples are too small to conclude that small differences in survival exist as suggested by weight data. Thirty-four ducks died on the sanctuary; they had a shot-wound incidence of 32.4%. Live Mallards had a shot-wound incidence of 25.2%. While not statistically significant, the difference again suggests that shot wounds were responsible for the early death of a few Mallards. Bellerose's (1953) band recovery data revealed no difference in survival between wounded and shot-free Mallards, but some loss of wounded birds could have occurred before he sampled the population.

Control Experiments

In 1963–1964, 18 tons of grain was distributed to Mallards at Calgary by the Alberta Fish and Game Association. The next winter, 70 tons was distributed at a cost of $3,723. The volume increased in the second winter partly because more ducks were being fed, but mostly because the second winter was much more severe. The ducks depended on supplied grain for a longer period and their daily food requirement would be higher in 1964–1965 as a result of lower temperatures (Kendeigh 1945).

In view of the large flock size in 1964–1965, agencies and individuals concerned agreed that some control was necessary to avoid similar concentrations in future winters. The ducks represented a potential hazard to aircraft at the Calgary airfield and the feeding program could not be justified as sound management.

Feeding itself undoubtedly aided the build-up by encouraging Mallards to remain in the protected areas and by increasing the number of survivors that might return in successive years. Wintering flocks elsewhere in Alberta[5] were not fed and none increased from 1963–1964 to 1964–1965 as did the Calgary flock. Most appeared to decrease.

The two main recommendations for 1965–1966 were to discontinue feeding and to conduct a scare program. It was also recommended that late-fall hunting should be encouraged in problem areas and that, where possible, effluents responsible for open water be eliminated, or at least rendered unavailable to ducks. Nothing could be done about the effluents, and hunting regulations remained unchanged that autumn.

The scare program started on 2 October and involved 10 acetylene exploders (Stephen 1961) located along the Bow River (Figure 1). At first, weekend use of exploders was sufficient to scare most of the ducks from the city, but by late October an increase in ducks necessitated daily continuous use of exploders. In early December, about 5,000 Mallards were present and the exploders were having no apparent effect on flock size, so scaring was discontinued. Likewise, a resumption of scaring from 3 to 21 January did not reduce the number of Mallards (3,500) then present.

To determine the feasibility of reducing the flock by transplanting, 1,262 Mallards were net-trapped from 22 January to 3 February, and released in British Columbia. Costs for trapping and airlifting averaged about $1.70 per duck. Dispersal of these ducks has already been discussed.

In 1966–1967 there was no artificial feeding; the hunting season was extended from 4 to 31 December and the regulation prohibiting hunting within 100 yards of the Bow River was removed. Permission was obtained to shoot within city limits and teams of shooters comprised of wildlife agency personnel and city police shot Mallards under permit on dates given in Table 2. Altogether, 506 were shot.

Except for the outright removal of ducks, results of the various management practices are difficult to evaluate because factors such as weather and natural food supply can affect migration. Also, more than one technique was used simultaneously. In both winters there was a substantial reduction in flock size, suggesting that harassment did cause many ducks to migrate. This is in contrast to the two previous winters when, with no scaring, the numbers remained relatively high throughout fall and winter. On the other hand, the ducks were fed the first two winters but not the last two, so lack of supplementary feeding may have been largely responsible for the declines accompanying scaring and shooting. This is supported by events in later years when, with no feeding, scaring or shooting, flock numbers have remained relatively low.

[5]Counts of other flocks were made by Alberta Fish and Wildlife Division Officers.

A comparison of the distribution of direct hunting recoveries made after 1 October 1965 (after scaring started) with that for 1964 reveals no increased movement of Mallards to the United States that might be related to the scaring. Relatively more direct recoveries were made within 20 miles of Calgary in 1965 (66%) than in 1964 (21%). The direct recovery rate for this area increased from 1.1% in 1964 to 4.3% in 1965, suggesting that control measures increased local hunting mortality. Even allowing for non-reported bands (Geis and Atwood 1961), however, any increased kill attributable to control measures would probably not exceed 10% of the flock.

Removal of ducks by trapping and transplanting would be economically impractical even if enough could be caught to reduce materially a large flock. It also has dubious public-relations value. Finally, it did not prevent a significant portion of the transplanted ducks from returning the next winter. Shooting ducks within city limits is not practical for administrative reasons and is undesirable for public relations. It appeared to accomplish little more than the scare program, which also created public relations problems.

Open water, available food, and protection from hunting are the main factors that cause Mallards to forego migration in Alberta. Little can be done to eliminate open water in winter. But all deliberate feeding and probably some accidental feeding (e.g., in stockyards) can be prevented. If ducks are forced to seek food outside the protected area, harassment by hunters will be an added stimulus for migration.

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The Feeding Ecology of the Northwestern Crow on Mitlenatch Island, British Columbia

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Butler, R. W. 1974. The feeding ecology of the Northwestern Crow on Mitlenatch Island, British Columbia. Canadian Field-Naturalist 88: 313–316.

Abstract. A study of the summer foods and feeding habits of the Northwestern Crow (*Corvus caurinus*) was made in the seabird colony on Mitlenatch Island off the coast of British Columbia. The crows used the intertidal, meadow, and nesting-seabird areas as sources of food. Techniques they employed to obtain these foods were observed. One hundred and eighty-four regurgitated pellets were examined and the volume of each food item was estimated.

Introduction

The food and feeding habits of many corvids have been well documented in Europe (Collinge 1910, 1924; Campbell 1936; Lockie 1955, 1956; Fog 1963; Holyoak 1968; Clegg 1972) but less so in North America (Aldous 1942; Emlen 1940). Most work in North America has been done in relation to agriculture or depredations of livestock, or other birds (Lumley 1937; Baker 1940; Bent 1946; Kalmbach no date; Stickley and Guarino 1972).

The Northwestern Crow (*Corvus caurinus*) is a small sociable crow, known as a common seashore scavenger and opportunist along a narrow Pacific coastal strip from southern Washington State to Alaska (Godfrey 1966). During the summer many seabird colonies support a small population of this crow, where it acts as a predator and scavenger.

Description of Study Area

Mitlenatch (49°57′ N, 125°00′ W) is a rocky 88-acre island located in the northern reaches of Georgia Strait, British Columbia. It is a low and well vegetated islet, compared to most seabird colonies. Two principal bays are connected by a grassy 6-acre meadow which is bordered by two rounded knolls less than 180 feet in height. Grasses and xeric plants dominate the island because of its dry conditions, while clumps of willow (*Salix* sp.) and ninebark (*Physocarpus capitatus*) with some oceanspray (*Holodiscus discolor*) overflow from the fissures in the basaltic rock. Two clumps of lodgepole pine (*Pinus contorta*) and a fairly extensive deciduous forest composed of trembling aspen (*Populus tremuloides*), willow (*Salix* sp.), and bitter cherry (*Prunus emarginata*) is the only major tree cover. Most of the crows using the island nest in this forest.

The larger of the two bays, called Camp Bay, has a low intertidal slope and is extensively used by the crows. It is approximately half covered with pacific oysters from under which the crows obtain much of their food. The meadow has scattered patches of blueberries and blackberries which, when in season, form a large portion of the crows' diet. The remainder of the island is a nesting area for about 2800 pairs of Glaucous-winged Gulls (*Larus glaucescens*). The southerly exposed cliffs support about 350 pairs of Pelagic Cormorants (*Phalacrocorax pelagicus*) and over 100 pairs of Pigeon Guillemots (*Cepphus columba*). The summer population of Northwestern Crows was determined by spring nest counts and sample censuses through the summer, and was found to be about 35 adults and their offspring, making a total population of about 135 crows. Up to 13 birds departed each morning just before dawn for the nearby islands and were observed to return to Mitlenatch only to roost in the evening during the breeding season.

Methods and Results

An analysis of the crows' food was made by examination of regurgitated pellets. One hundred and eighty-four pellets were collected from 2 June to 31 August 1973. Samples were taken regularly from searches of all areas of the island except the heavily wooded portions where locating pellets was difficult. Pellets were broken onto a piece of white paper, separated into parts, and estimates made of the volume of each kind of food. This system reveals only indigestible parts, but direct

TABLE 1 — Number of pellets, per period, containing major food items

Food item	June 1–15	June 16–30	July 1–15	July 16–31	August 1–15	August 16–31
Blackberry	1	21	48	27	1	2
Shore crab	9	22	33	14	7	15
Roughage (mosses and grasses)	13	15	20	13	10	20
Red rock and kelp crabs	2	4	4	5	4	3
Bones and meat	0	2	3	3	5	6
Little neck clam	3	7	9	3	1	3
Blueberry	0	0	11	3	0	0
Fish bones	4	1	1	1	6	11
Number of pellets	14	33	54	32	17	34

observation showed that few items consumed did not appear in the pellets. Therefore most food items are represented, although the volume consumed may not be accurately represented in the volume percentages owing to variation in digestion rates.

Foods Eaten

The bi-weekly variations in the foods eaten are shown in Table 1, and percentages of the total season's food represented by each kind of food in Table 2.

Direct observations of the crows' feeding activities were also made. During June and early July adult crows concentrated feeding activities to the beaches, primarily above the 4-foot tideline. Movements on the meadows in search of blackberries and blueberries occurred in July but when the gull eggs began hatching most of the crows moved into the seabird colony to feed chiefly on regurgitated fish from the gulls and cormorants. Finally, near the end of August the crows returned to the beaches.

1. Intertidal Foods

The shore crabs (*Hemigrapsus nudus* and *H. oregonensis*) are very abundant on the upper beach around most of the island. They were easily obtained by the crows in all areas of the island except during the highest tides. Camp Bay was the favorite feeding site. The crabs were such easy fare that on occasion a crow would release a captured one because of presumed lack of interest. Even when the number of crow pellets decreased in July the crabs still were present in

TABLE 2 — Percentage (by volume) of various foods in 184 pellets collected from June 2 to August 31, 1973

Food	Volume (%)
Blackberry (*Rubus ursinus*)	26.8
Shore crabs (*Hemigrapsus nudus* and *H. oregonensis*)	18.6
Roughage (various grass stems and mosses)	14.4
Feathers (gull, cormorant, and unknown)	4.5
Red rock (*Cancer productus*) and kelp crabs (*Pugettia producta*)	4.1
Bones and meat (other than fish)	2.8
Little neck clam (*Protothaca staminea* and *P. semidecussata*)	2.7
Blueberry (*Vaccinium caespitosum*)	2.1
Fish bones (probably *Clupea pallasii*, *Ammodytes hexapterus*, and others)	2.0
Blue mussel (*Mytilus edulis*)	1.8
Cockle (*Clinocardium nuttallii*)	1.5
Seaweed (various species)	1.0
Sea urchin (*Strongylocentrotus* sp.)	0.8
Chiton (*Lepidozona cooperi*)	0.8
Carpenter ant (*Camponotus* sp.)	0.5
Red ant (unidentified sp.)	0.5
Waxberries (*Symphoricarpus albus*)	0.5
Unidentified terrestrial snail	0.4
Cormorant eggshell	0.4
Gooseberry (*Ribes divaricatum*)	0.3
Unidentified beetle	0.3
Periwinkle (*Littorina sitchensis*)	Negligible
Coast garter snake (*Thamnophis elegans*)	"
Gull eggshell	"
Other foods (stolen from humans, earth, etc.)	4.0
Total pellets, 184	

the pellets in somewhat constant numerical proportions.

The crows captured shore crabs by quickly lifting rocks or oysters on the beach and picking

the crab from beneath. Legs and pincers were pulled from the larger crabs and devoured before the larger remaining pieces. Small crabs were swallowed whole.

Little neck clams (*Protothaca staminea* and *P. semidecussata*) showed a marked decrease in the composition of the pellets towards mid-August, and then an increase. This clam is locally abundant but was much more difficult for the crows to obtain than crabs, and more energy was required to open the clams than to capture crabs. When the crows turned their attention toward fish and carrion in the seabird colony, the search for little neck clams was almost totally abandoned. Nevertheless the technique used by the crows in finding and opening the clams is most intriguing.

The crow paces the beach and when a clam is found the bird inserts its opened bill into the gravel around the shallow-living clam. The mollusc is then lifted out of the gravel and flown to the nearby rocks where it is dropped until opened. Opening a clam often took more than half a dozen attempts. A similar technique has been observed by Clegg (1972) in the Carrion Crow in England. Shells of the mud clam (*Mya arenaria*) were found in the piles of discarded shells left by the crows and were assumed to be eaten by the birds, although much less frequently than the little neck clams. They never appeared in the pellets.

Red rock crabs (*Cancer productus*) and kelp crabs (*Pugettia producta*) were eaten when available. Both of these species tend to be under water even at the lowest tides.

2. *Berries*

In early July the berry of the trailing blackberry (*Rubus ursinus*) turned red and the crows began eating them. During July when most of these berries were abundant, they appeared in over 80% of the pellets. A sharp decline of blackberries (both fruit and seeds) occurred in August as the season ended. Blueberries (*Vaccinium caespitosum*) were also eaten in July but their season ended much earlier than that of the blackberry. Both were generally poorly digested. The actual time from consumption to regurgitation of individual items is unknown, but it appeared to vary widely. A few freshly regurgitated pellets contained almost unbroken druplets while others showed varying stages of digestion. On 14 July about 15 crows gathered in a patch of blueberries and were observed eating the berries. Less than an hour later the birds moved to the beach and regurgitated 14 pellets. All consisted almost totally of blueberries with no signs of digestion.

3. *Seabird Colony*

By the end of July most of the gull eggs had hatched and most of the chicks were less than a month old. At this time the adult gulls made foraging trips to catch mostly herring, sand lance, and other small fish and invertebrates. These were fed to the young gulls. The strong territoriality of Herring Gulls is well documented by Tinbergen (1961), and Glaucous-winged Gulls show similar behavior patterns (Vermeer 1963). Wandering young gulls are attacked by neighboring nesters, and being unable to fend for themselves, many are killed. The crows scavenge these gulls. Any disturbance to the nesting gulls attracts nearby crows in hopes of obtaining fish regurgitated by alarmed adults and young. An abundance of fish bones found in crow pellets from the cormorant colony suggests that cormorants are the chief source of this form of food. Similar observations were made on Mandarte Island (Drent and Guigent 1961; Drent et al. 1964). Fish bones were difficult to identify and were tallied as 'fish bones.' They appeared in nearly 30% of the pellets in the first 2 weeks of August and then their percentage composition declined. Other bones and dried meat from carrion or young seabirds taken from the nests also appeared to follow this trend from about late June onwards. Drent and Guiguet (1961) observed crows taking young cormorants from the nest on Mandarte, and this activity probably occurs on Mitlenatch as well. No young gulls were seen to be attacked by the crows although a very young bird, probably a guillemot or cormorant, was seen to be carried over Camp Bay by a crow.

Gull, guillemot, and cormorant eggs were pilfered readily by the crows. Most concerted drives occurred in the cormorant colony, probably as a result of the cormorant's incapability to drive the crows more than striking distance from the nest. Disturbance of the cormorant colony allowed countless eggs to be pilfered by the crows. Under one crow's nest the ground was littered with cormorant eggs.

Undoubtedly cormorant eggs, and to a lesser extent gull and guillemot eggs, are a major source

of food for the crow although this is not readily apparent in the data. The technique used in pilfering seabird eggs varies among species. A cormorant egg is easily carried by the crow and is picked up after a hole has been pecked in the egg and the bird's bill has been inserted. Eggs are usually eaten in favorite areas although occasionally they are dropped onto rocks and licked from the surface. Gull eggs are probably too large for the crow to carry and so the birds must drive the nesting gull from its nest with incessant swoops. Only once did I observe a crow eating a guillemot egg. Whether the egg was dropped or pecked open, and how the crow obtained the egg, is unknown.

The rate of digestion of the eggs is undoubtedly high. Because of the lack of hard parts only rarely did signs in the form of shell appear in the pellets.

4. Other Food

During the rainy weather the crows were seen to collect gull feces from the rocks and feed them to their begging young. On two occasions a crow was seen with a young deer mouse (*Peromyscus maniculatus*). The actual catching of the mouse was not observed although it is assumed that the crow made the initial kill. The coast garter snake (*Thamnophis elegans*) also feeds in the intertidal portions of the seashore and wanders into the seabird colony (Campbell 1969). Crows were seen to capture snakes on the beach where they were carried to driftwood logs and pecked from head to tail. Strips were pulled from the carcass and eaten. The largest snakes eaten were about 18 inches long. It is interesting that, according to Campbell (1969), snakes prey upon nestling crows.

Acknowledgments

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A New Live-Trap and Techniques for Winter Trapping Small Mammals

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Abstract. A new small-mammal live-trap and techniques for its year-round use in northern regions are described. Mammals ranging from small shrews (*Sorex cinereus*) to chipmunks (*Tamias striatus*) were routinely captured. Less than 1% "trap mortality" was experienced in an area where continuous snow cover is present during the winter and where ambient air temperatures in the vicinity of the trap were as low as −18°C.

Introduction

Live-trapping small mammals on a year-round basis presents unique problems in northern regions. The presence of substantial and continuous snow cover hampers trapping efforts and trap operation, and sub-freezing temperatures are detrimental to animal survival in the traps. The primary concern is to minimize mortality in the traps while ensuring proper operation of traps in all types of weather. Minimizing mortality is particularly important to long-term studies where repetitive sampling is frequent. For example, if each sampling results in 5% mortality it would take only 10 samples to reduce a trappable population to 60% of its original number. Where small-mammal studies have been attempted in winter, this relatively high rate of mortality in the traps has been reported when traps were checked every 24 hours. Beer (1961) in a Minnesota study of the winter home ranges of *Peromyscus leucopus* and *Clethrionomys gapperi* reported 5–10% mortality. Iverson and Turner (1969) experienced 3.2% mortality in Manitoba for a *Microtus pennsylvanicus* field population during winter. Pruitt (1959) and Brown (1973) reduced mortality in the traps during winter by checking them every 8 hours. This, however, unnecessarily increases the effort required to sample winter populations of small mammals.

Solutions to various problems of winter mortality have been found during a long-term, year-round study of small mammals near Rhinelander, Wisconsin. A new small-mammal live-trap and techniques presently in use are described which permit year-round trapping with minimal mortality even when traps are checked once every 24 hours. It is hoped that this will aid and encourage others to undertake studies in a greatly neglected area of research—the winter ecology and population dynamics of small mammals.

The most important considerations in minimizing winter mortality in traps are providing the animal with proper food and water, and minimizing heat loss. Although the first appears to be more important than the last, any means provided to reduce heat loss enhances the animal's welfare and adds to the flexibility of the trapping procedure.

With these factors in mind, the suitability of commercially available live-traps for winter use on the species indigenous to the study area was considered. The Sherman live-trap was rejected because of inadequate space for nest material. The Longworth trap's tripping mechanism may not be sensitive enough to capture mammals weighing 2–3 grams (Grant 1970), so a new live-trap was designed (Figure 1).

Materials and Methods

The trap consists of a nest box surrounded on two sides by an entrance passage; one section of this passage contains a door with two locking flaps and the other a treadle-operated, door-release lever. The trap is constructed of galvanized sheet metal (28 gauge), 10-penny galvanized finishing nails, and galvanized wire (16 gauge). A local sheet-metal worker fabricated all parts and assembled the trap body at a cost of $4.25 each. An additional 16-hours labor were required to install treadles and doors on 100 traps.

The trap body consists of three pieces: a floor, a continuous exterior-interior wall, and a lid (Figure

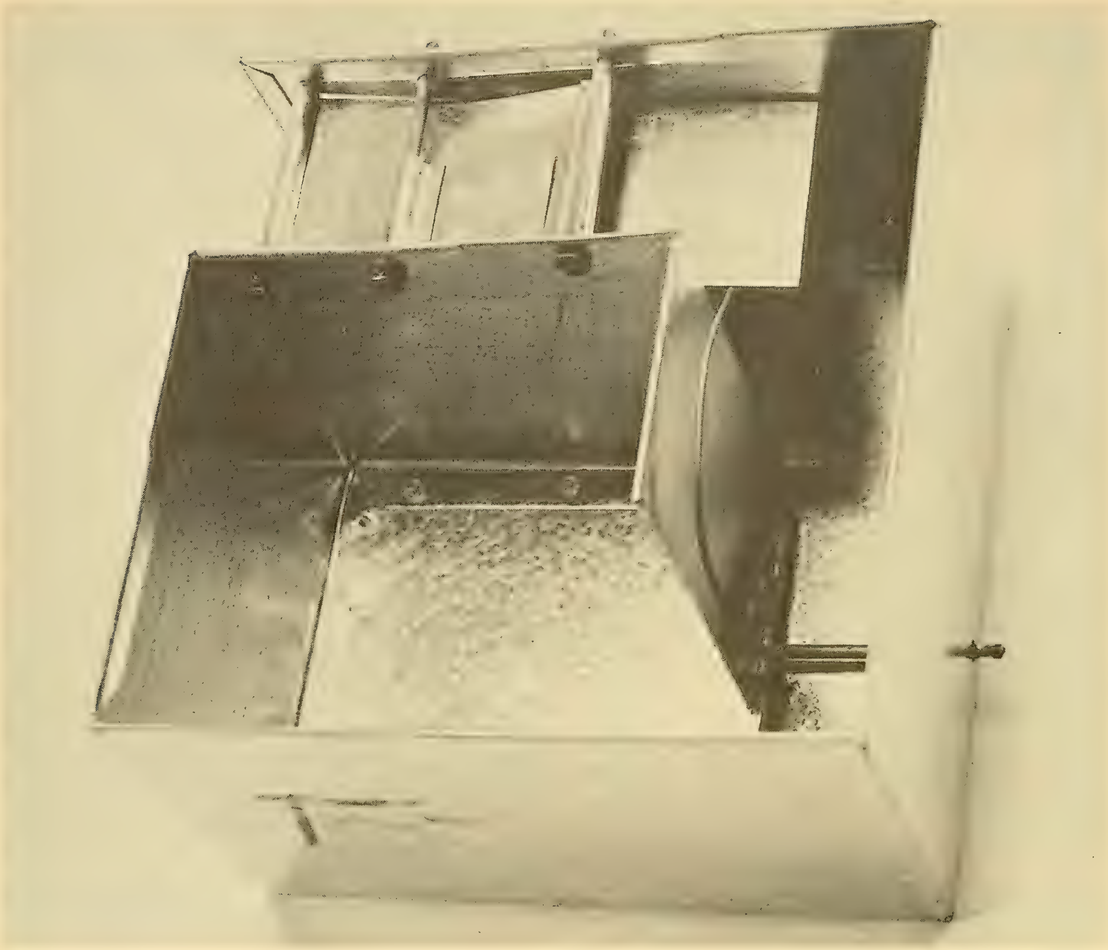

FIGURE 1. Oblique view of the interior of a completed live-trap when trap is set.

2). The top of the wall is rolled over for strength and the bottom is flanged. The flanges on the exterior walls are spot-welded to the bottom of the floor, and those on the interior walls to the top of the floor. The edges of the lid are also rolled over for strength. It is not recommended that holes be predrilled in the sidewall for door, flaps, and treadle until after a number of traps have been completely assembled. The approximate location of the holes is shown in Figures 2 and 3.

The door and the two locking flaps are all hinged at the top with 10-penny nails. To install door and flaps, hinges must first be fashioned on one end. With the aid of a vise, the end of the door or flap is rolled around a rod of a diameter slightly larger than a 10-penny nail. After the door and flaps are cut to proper length, they can be hung on nails inserted with their heads toward the trap center. The pointed end of the nail can then be flanged to prevent removal by clamping in a vise. (The nail should be cut to proper length and rough edges taken off with a grinder.)

Door A should be hung in the position shown (Figure 3) and cut long enough to extend beyond the interior wall and rest on the wire that will be soldered to the treadle. Flap B should be hung $^1/_4$ inch from the top of the trap to prevent escapes between the hinge and lid. (This will require notching the lid to accommodate the nail for Flap B and ensure a tight fit. Notching should be done uni-

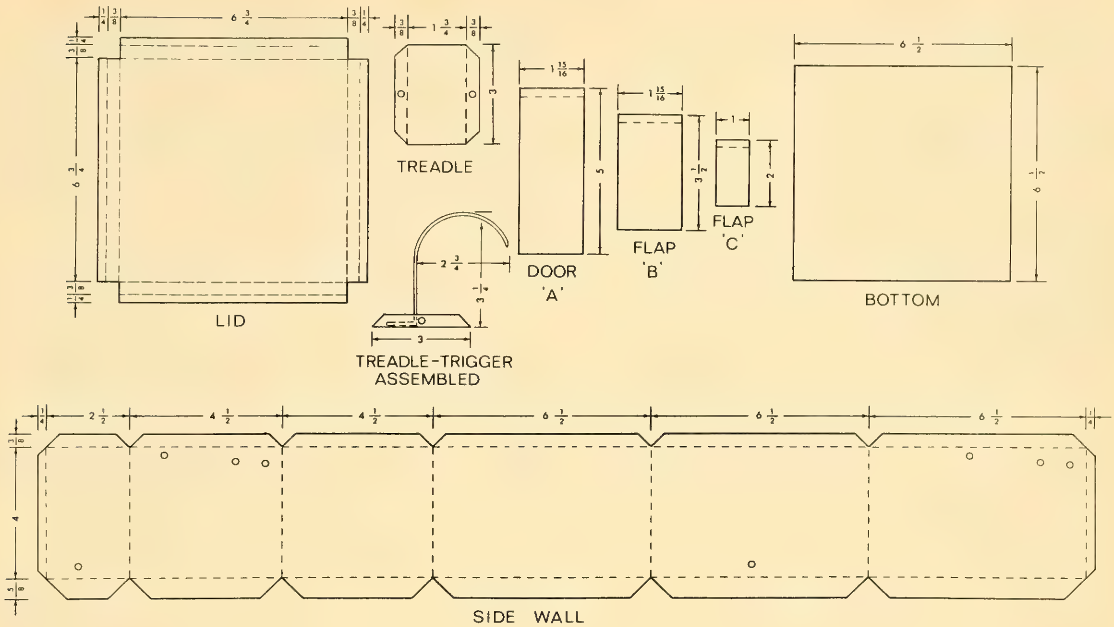

FIGURE 2. Patterns for components of the live-trap. All dimensions are in inches.

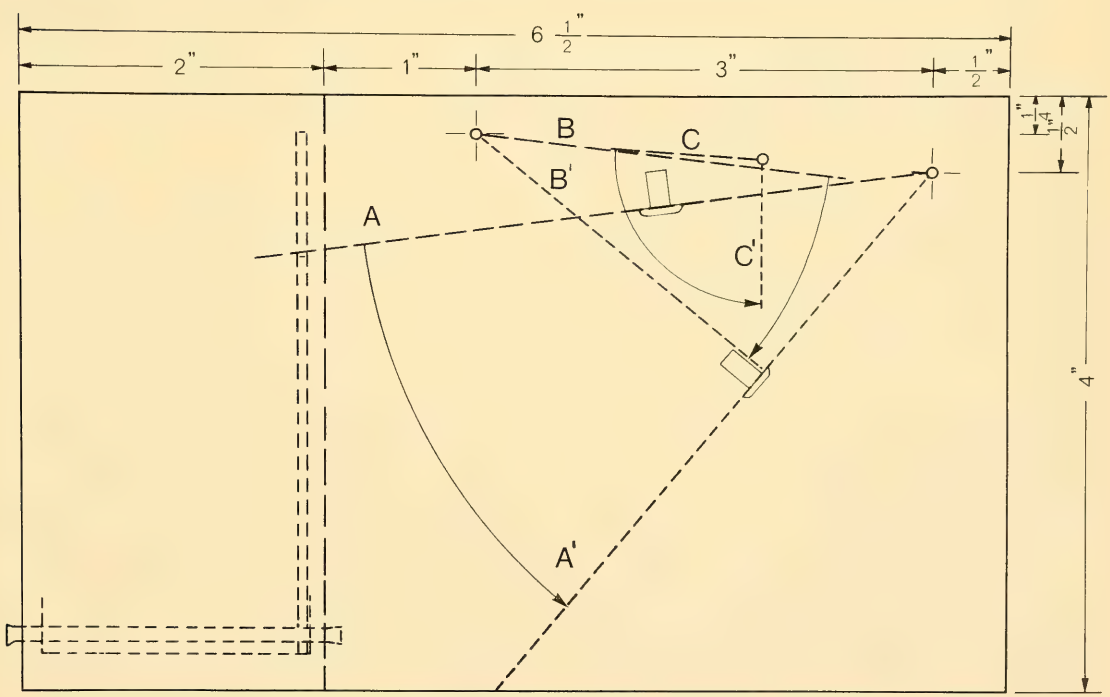

FIGURE 3. Side view of location of door and interlocking flaps in the "set" (A, B, C) and "tripped" (A^1, B^1, C^1) positions.

formly so that lids are interchangeable.) Flap B is cut long enough to contact Door A at a right angle and hold it in place (Figure 3). At this point a "pop" rivet, $^1/_8 \times ^1/_4$ inch, is installed on Door A to act as a stop. Flap C is then hung directly over the point at which Door A and Flap B come in contact but just low enough (about $^3/_8$ inch) not to require notching the lid. Flap C is cut just long enough to clear Flap B when the mechanism is tripped. Flap C prevents Flap B from being pushed up if an attempt is made to raise either Door A or Flap B.

A galvanized wire 7 inches long is bent into an arc about $2^3/_4$ inches in diameter (Figure 2). One end is soldered to the treadle about $^1/_8$ inch from the treadle pivot. When the wire is installed the tip should extend about $^1/_4$ inch into the passage for Door A to rest upon when the trap is set. The tip of the wire should be rounded for smoother operation. The treadle is suspended from a 10-penny nail about $^3/_{16}$ inch off the floor.

Before setting the trap a 4-inch square of $^1/_2$-inch particle board is placed on the nest box floor and the sides are lined with approximately 10–15 grams of cotton[1] (depending on the season of the year) leaving an open center for bait. After the door mechanism has been set and the treadle adjustment has been checked, the lid is placed on the trap and held down by means of a heavy "4-way" rubber band (size 2210, Keener Rubber, Incorporated).[2]

Peanut butter in $^3/_4$-ounce "souffle" or "portion control" cups was used as bait. The cups were prevented from sticking together during handling by dipping the exposed peanut butter surface in rolled oats, and then in warm weather by freezing. A source of water was found necessary, especially for microtines, and was provided by a slice of apple.

Two methods were used to remove animals from the trap. Both procedures utilized 3-mil clear polyethylene bags, $10^1/_2 \times 8 \times 21^1/_2$ inches. For sciurids the rubber band was removed and the bag was wrapped around the side of the trap opposite the doors and the trap cover slid back to allow the animal to jump into the bag. For smaller species, the trap was placed at the bottom of the bag and the cover removed. Individuals which did not leave immediately were dumped by inverting the trap. They were then either examined within the bag or, if marking or weighing was required they were transferred to cones fashioned from hardware cloth, 3 mesh/inch.

The trap shelter described by Iverson and Turner (1969) was modified to accommodate the new trap and was used year-round to provide shade in the summer and shelter from snow in winter. The dimensions were changed to $18^1/_2$ inches long, 12 inches wide, and 6 inches high. The first set of shelters was constructed of 1-inch lumber and plywood as described by Iverson and Turner (1969); however, they were destroyed by porcupines (*Erthizon dorsatum*), which apparently favored the glues in the plywood. Therefore, a second set was constructed utilizing only 1-inch lumber. These proved to be immune to porcupine damage. The shelter was found to be satisfactory for snow depths up to 18 inches. When depths reached 30 inches, however, it became increasingly difficult to shovel down to the shelter lid while we were on snowshoes, especially through crusted layers. Thus a trap shelter similar in principle to that described by Pruitt (1959) would appear to be more suitable where the snow cover regularly exceeds 24 inches.

Results

The trap, bait, and trap shelter combination described have proved to be effective. Mammals ranging in size from small shrews to chipmunks were routinely captured. Although traps were checked only once every 24 hours, successive weighings of recaptured individuals during a 1-week trapping period indicated little or no weight change associated with capture procedures. The use of plastic bags and hardware-cloth cones permitted rapid processing with little likelihood of harm to the animal or trapper, and resulted in escapes being a rarity. Winter mortality in the traps for cricetids was very low in comparison to that reported in the literature. In three winters (November to April) of monthly trapping, only two out of 740 captures (0.27%) resulted in death of an animal. In comparison, four years of monthly trapping during the snow-free season (May to October) resulted in four deaths out of 1695 captures

[1]W. A. Fuller (personal correspondence 1/15/74) has found that terylene batting is superior to cotton for nesting material because it does not absorb moisture and thus resists compaction with resultant loss of insulative value. This material was not evaluated in this study.

[2]Mention of trade names does not constitute endorsement of the products by the USDA Forest Service.

(0.24%). The fact that these percentages are near zero and equal, indicates that mortality resulting from the trapping scheme described is approaching a rate which is probably unavoidable. These low mortality rates were obtained even when ambient temperatures in the vicinity of the trap were as low as −18°C. But, there is a problem in keeping shrews alive, which is probably associated with their high metabolic rate and the nature of the food provided (peanut butter and apples).

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Breeding Biology of the Hooded Merganser in Southwestern Quebec, including Interactions with Common Goldeneyes and Wood Ducks

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Bouvier, J. M. 1974. Breeding biology of the Hooded Merganser in southwestern Quebec, including interactions with Common Goldeneyes and Wood Ducks. Canadian Field-Naturalist 88: 323–330.

Résumé. De 1970 à 1972, une étude fut entreprise à Harrington dans le sud-ouest du Québec. Les premiers becs-scie couronnés (*Lophodytes cucullatus*), garrots communs (*Bucephala clangula*) et canards huppés (*Aix sponsa*) sont arrivés à Harrington durant la deuxième ou troisième semaine d'avril, après le dégel de la rivière Rouge. Ces canards ont pondu un total de 313 oeufs dans 27 nids logés dans des nichoirs. Les couvées complètes contenaient de 5 à 18 oeufs. Pas moins de 10 couvées contenaient des oeufs de plus d'une espèce. Les femelles des trois espèces ont incubé des couvées mixtes. Les jeunes becs-scie courronés quittèrent le nid le matin ou tôt l'après-midi durant la deuxième ou troisième semaine de juin. Dix jeunes becs-scie ont quitté un nichoir en moins de 2 minutes. Le succès de nidification des becs-scie couronnés fut de 82.4%, et celui des garrots 57.1%. L'abandon du nid a été la cause majeure d'insuccès. Le taux d'éclosion pour les nids réussis a été de 90.3% pour les becs-scie couronnés, et 86.5% pour les garrots communs. Dans les nids réussis, la plupart des oeufs non éclos étaient infertiles ou peu développés. Les garrots communs et les canards huppés ont fait éclore 9 oeufs de becs-scie sur 10, tandis que les becs-scie couronnés ont fait éclore 14 oeufs de garrots sur 17; quatre oeufs de garrots, pondus dans un nid de canard huppé n'ont pas éclos. Deux femelles de becs-scie couronnés, baguées sur leur nid en 1971, ont de nouveau niché à Harrington en 1972.

Abstract. From 1970 through 1972, a study was carried out near the Rouge River in southwestern Quebec. The first Hooded Mergansers (*Lophodytes cucullatus*), Common Goldeneyes (*Bucephala clangula*), and Wood Ducks (*Aix sponsa*) arrived in Harrington during the second or third week of April, when the ice on the Rouge River had completely disappeared. Twenty-seven nests located in nest boxes contained a total of 313 eggs, with completed clutches containing from 5 to 18 eggs. No less than 10 clutches contained eggs of more than one species. Instances of females of all three species incubating joint clutches were recorded.

Young Hooded Mergansers left their nests in the morning or early afternoon during the second or third week of June. A complete nest departure of 10 young mergansers was completed within a 2-minute period.

Nesting success of Hooded Mergansers was 82.4% and of Common Goldeneyes 57.1%. Most of the unsuccessful nests had been abandoned. Hatching success of Hooded Merganser and Common Goldeneye eggs in successful nests was 90.3% and 86.5%, respectively. Most of the unhatched eggs in successful nests were infertile or underdeveloped. Common Goldeneyes and Wood Ducks hatched 9 of 10 merganser eggs, while Hooded Mergansers hatched 14 of 17 goldeneye eggs; four goldeneye eggs laid in a Wood Duck's nest did not hatch. Two female Hooded Mergansers, banded on their nests in 1971, returned to the study area during the 1972 breeding season.

Introduction

Much information has been published on the nesting biology of the Common Goldeneye (*Bucephala clangula*) and Wood Duck (*Aix sponsa*) in North America. But there are few published data on the nesting biology of the Hooded Merganser (*Lophodytes cucullatus*), apart from one article dealing with some interesting aspects of its breeding biology in Benton County, Oregon (Morse et al. 1969). The present study was made in the municipality of Harrington, southwestern Quebec, during the breeding season from 1970 to 1972. Between 13 and 18 nest boxes were available during the three years, and I studied a total of 27 duck nests during 3 seasons: 8 nests in 1970, 11 in 1971, and 8 in 1972. Of these, 11 were of Hooded Mergansers and 8 were mixed clutches of Hooded Mergansers with another species. The arrival of the adults on the breeding grounds in spring, clutch size, joint clutches, nest attentiveness and success, and dates of hatching and departure of the young from the nest are given. Sequences of a partial and also a complete departure from nest boxes of newly hatched Hooded Mergansers are described. Evidence of fidelity of female Hooded Mergansers to the nest site is presented.

Study Area

The study area was in the lower Laurentian Mountains, about 80 miles (129 km) northwest of Montreal, in managed woodlands east of the Rouge River which flows into the Ottawa River near Calumet, Quebec. Elevations range from 550

FIGURE 1. Wooden nest box (Number 13) fastened to a flooded cedar. Photographed in June 1971 at Lac des Pins, Harrington, Québec.

feet (165 m) to 1,200 feet (366 m) above sea-level. The average soil type in the area is of the Ste. Agathe Series: fine sandy loam, with good drainage, and excessively stony. Small beaver-flooded lakes and ponds bordered by trees constituted the breeding habitats. The eastern white pine (*Pinus strobus*), white spruce (*Picea glauca*), red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), white birch (*Betula papyrifera*), beech (*Fagus grandifolia*), and sugar maple (*Acer saccharum*) are common trees.

Methods

The nest boxes were fixed on metal posts and flooded trees, from 3 to 7 feet (1 to 2 m) above normal high-water levels, at least 35 feet (10 m) apart in most cases, and 7 to 125 feet (2 to 38 m) from shore. Predator guards were not used. The nest boxes were of two types: one, made of 1-inch-thick rough lumber, had a 10-inch-square floor and top with sides about 24 inches high (Figure 1); the other, made of 10-inch galvanized stovepipe, about 24 inches high, was fitted with a conical metal top and a circular wooden floor (Figure 2). The entrance in both models was 4 inches wide by 3 inches high. Small holes in the floor ensured good drainage. Hardware cloth, 16 inches by 3 inches, was placed inside the box, from the base of the entrance to the floor to ensure that the newly-hatched ducklings could easily climb out. About 4 inches of sawdust or wood shavings on the floor provided a nest base.

In 1970 I checked all nest boxes at least once towards the beginning of incubation and once after the breeding season in early March, to determine the nesting success. In 1971, I investigated each box an average of five times, from laying of eggs until departure of the young. In 1972, I checked each box about five times, but only after the laying was completed in most cases. A box containing at least one egg of any species was deemed to constitute a nest. In 1971, some incubating female Hooded Mergansers were fitted with aluminum leg bands distributed by the Canadian Wildlife Service.

Results

Arrival on the Breeding Grounds

The first Hooded Mergansers, Common Goldeneyes, and Wood Ducks were seen usually during the second or third week of April, as soon as the ice on the Rouge River had completely disappeared. Table 1 shows the relationship between the

FIGURE 2. Nest box made of galvanized stovepipe and fixed on a metal post.

first arrivals in spring and the thawing of the Rouge River. The ducks seen before the spring break-up were usually on small patches of open water where creeks flowed into the lake, or were observed in flight.

Nest Boxes Available and Used

More than 15 nest boxes were put up by Canadian International Paper personnel during the 1966 winter and were available to ducks in the spring of 1967. Thorough investigation of all boxes was not done until the spring of 1970. The ducks used 8 out of 15 boxes in 1970, 11 out of 18 in 1971, and 8 out of 13 in 1972 (Table 2). A box was considered not available if it had been taken down, had been blown down by wind, or had no roof.

Clutches

Out of 27 clutches in 1970–1972, 11 Hooded Merganser clutches contained from 5 to 18 eggs, three Common Goldeneye clutches contained seven to nine eggs, and one Wood Duck clutch contained 10 eggs (Table 3). Godfrey (1966) reports that Hooded Mergansers lay 5 to 12 eggs, Common Goldeneyes 6 to 15 eggs, and Wood Ducks 5 to 15 eggs.

I encountered no less than 10 clutches containing eggs of more than one species (Table 3). Instances of females of all three species incubating joint clutches were recorded. Hooded Mergansers incubated from one to four goldeneye eggs in six nests; Common Goldeneyes incubated one and four merganser eggs, respectively, in two nests; in

TABLE 1 — Relationship of thawing of Rouge River and arrival of Hooded Mergansers, Common Goldeneyes, and Wood Ducks in spring 1969–1971

		Arrival of first ducks		
Year	Date of thawing of Rouge River	Hooded Merganser	Common Goldeneye	Wood Duck
1969	April 13	April 14	April 9	April 15
1970	April 18	April 18	April 11	April 18
1971	April 22	April 23	?	April 10

TABLE 2 — The availability and occupancy of boxes in 1970, 1971, and 1972. NA=Not available.

Box number	Species occupying boxes 1970	1971	1972
13	merganser	merganser	merganser
6	merganser	merganser, goldeneye	merganser, goldeneye
1	Wood Duck, merganser	Wood Duck, merganser, goldeneye	merganser
14	merganser	merganser	—
11	merganser, goldeneye	—	merganser
5	—	merganser, goldeneye	merganser
12	—	goldeneye	goldeneye, merganser
7	—	—	—
2	merganser	merganser, goldeneye	NA
8	merganser	merganser, goldeneye	NA
3	—	goldeneye	NA
21	—	Wood Duck	NA
10	—	—	NA
4	—	NA	NA
18	goldeneye	NA	—
9	NA	goldeneye	—
15	NA	—	goldeneye
20	NA	—	goldeneye, merganser
16	NA	—	NA
17	NA	—	NA
19	NA	NA	—
Percent occupancy	53%	61%	62%

FOOTNOTE: In only one instance was a box NA in 1970 or 1971, occupied in the following year when it was available, and in two cases a 1970 NA box was occupied in 1972 (all three boxes were taken over by Common Goldeneyes, not Hooded Mergansers).

two nests, Wood Ducks incubated two Hooded Merganser eggs in one and three merganser eggs in the other. In the latter Wood Duck nest I found on 3 June 1971, four goldeneye eggs, and one live Hooded Merganser duckling still with egg tooth; because the goldeneye eggs showed no sign of incubation and were not observed in the nest box 21 days earlier, I presume they were deposited in the box while other eggs were hatching.

Interspecific competition for nesting sites occurs in other areas where these and other hole-nesting ducks breed: Kortright (1942) reports that Hooded Mergansers and Wood Ducks often lay eggs in the same nest and that Hooded Mergansers lay eggs in Common Goldeneye nests. Clutches of the Common and Barrow's Goldeneye (*Bucephala islandica*) containing from one to three eggs of the Bufflehead (*Bucephala albeola*) have been found on several occasions (Erskine 1960, 1961, 1972). Hooded Mergansers, Common Goldeneyes, and Wood Ducks in New Brunswick have laid in one another's nests (Prince, *in* Titman and Lowther (1971)). My observations showed that in most instances females of two species probably began laying in the same box simultaneously and the less aggressive abandoned the mixed clutch to the more aggressive.

Nest Attentiveness

During incubation and before the young leave the nest, the female Hooded Merganser spends most of her time on the nest: in 42 visits to merganser nests, I saw the females there 28 times (about 67%) (Table 4). Erskine (1972) made 515 visits to Bufflehead nests in British Columbia during incubation and found females present on 398 occasions (77%). I encountered female Common Goldeneyes in 9 out of 16 visits, and Wood Ducks in 4 out of 6 visits.

Leaving the Nest

In one nest young Hooded Mergansers remained for between 15½ hours and 19¼ hours; they left the box between 0915 and 1300 hours. Young mergansers left two other nests in the morning and one in the afternoon between 1410 and 1600 hours.

TABLE 3 — Clutch size, number of eggs laid by Hooded Mergansers, Common Goldeneyes and Wood Ducks, and incubating species, 1970–1972

	Clutch size												
	1	5	6	7	8	9	10	11	12	13	15	17	18
Non-mixed clutches													
Hooded Merganser		2	1				1		2	1		1	3
Common Goldeneye	1*	1*		2		1							
Wood Duck							1						
Mixed clutches													
Hooded Merganser† (+Common Goldeneye)**		1(4)				1(3)		1(3)		1(3)	1(3)	1(1)	
Common Goldeneye† (+Hooded Merganser)**					1(1) 1(4)								
Wood Duck† (+Hooded Merganser)**										1(2)			
(+Hooded Merganser +Common Goldeneye)**							1(3+4)						
Totals													
Hooded Merganser		3	1			1	1	1	2	2	1	2	3
Common Goldeneye	1*	1*		2	2	1							
Wood Duck							2			1			

*Abandoned before incubation.
†Species incubating.
**Number of eggs of this species in parenthesis.

TABLE 4 — Attentiveness of Hooded Merganser females during incubation and before the young leave the nest

Time of visits	Total number of visits to nest	Female found on nest	
		Occasions	Percent
Before 08:00	2	2	100
08:00–10:00	7	4	57
10:00–12:00	8	6	75
12:00–14:00	4	3	75
14:00–16:00	6	4	67
16:00–18:00	6	4	67
18:00–20:00	8	4	50
20:00–21:00	1	1	100

Morse et al. (1969) report that young mergansers usually remain in the nest one full day after hatching and are called from the nest the morning after. Young Buffleheads also stay in the nest for 24 to 36 hours and usually leave during the forenoon (Erskine 1972).

Young Wood Ducks were the first of the three species of hole-nesting ducks to leave their nests. Ducklings left two nests during the first week of June, and high winds blew box Number 21 into the water on 20 June 1971, four days before the eggs were due to hatch; these chicks would have departed at the latest about June 25. Young Hooded Mergansers usually left the nest during the second and third week of June. The latest dates that I saw female mergansers still on eggs was on 23 June 1970 and 26 June 1972. Newly-hatched Common Goldeneyes left their nests around the third week of June, but on 14 June 1970, Leslie Walker (unpublished data, Quebec Nest Record Card Program) saw a female goldeneye, with eight young, swimming on a small lake a few miles outside the study area.

I watched young Hooded Mergansers leave the nest on two occasions:

(1) between 0755 and 0758 hours on 17 June 1970, four young mergansers jumped from box Number 6, from about 1.5 m, into the water at the base where the female and six other young were waiting. The last two ducklings to depart dove underwater for about 4 to 5 seconds, then splashed about and rapidly swam towards the rest of the family. As soon as they arrived, the female quickly led the family towards dead timber standing in the pond;

(2) a complete departure sequence from box Number 13, whose entrance was 2 m above water, is described here. After visiting the nest on 18 June 1971 my observations were made from a concealed position in a car, 40 m from the box. The box was on a dead cedar, 7 m from shore.

0750—I opened the box cover. The female was on her young; she hissed once but made no attempt to fly away. One dry-looking, fluffy duckling looked up, eyes wide open; under her, two started cheeping vigorously; the others were dry-looking but not fluffy.

0752—I re-covered the box and returned to the car.

0935—female stuck head, neck, and shoulders out of entrance; pause; turned head to her left then back to the front; pause; turned head to her right then back to the front; pause.

0937—she slipped back into the box.

0944—she reappeared at entrance, looked in all directions as at 0935, but with shorter pauses.

0945—she flew out of the box into the water below, where she swam about in same spot.

0946—first young appeared at entrance; pause (6 to 8 seconds); jumped out of box into water beside female; pause (ca. 4 seconds); second young; pause (6 to 8 seconds); jumped; pause (ca. 4 seconds); third young; pause (6 to 8 seconds); jumped; pause (ca. 4 seconds); fourth young; pause (6 to 8 seconds); jumped; pause (ca. 1 second); fifth young; pause (6 to 8 seconds); jumped; pause (ca. 1 second); sixth young; pause (6 to 8 seconds); jumped; pause (ca. 4 seconds); seventh young; pause (ca. 14 seconds); jumped; pause (ca. 4 seconds); eighth young; pause (ca. 14 seconds); jumped; pause (ca. 4 seconds); ninth young appeared and immediately jumped; pause (ca. 4 seconds); tenth young; pause (ca. 2 seconds); jumped.

0948—female leading 10 young towards area of dead standing timber.

In less than 2 minutes after the first jump all 10 young were following the female on the lake.

This short departure sequence is similar to that described by Kortright (1942) for young Wood Ducks and young Common Goldeneyes. The departure sequence of young Buffleheads takes longer; one described by Erskine (1972) took 12 minutes after the first one jumped.

During departure sequences at Harrington, I did not hear the female merganser calling her young. This differs from a departure pattern described by Myres (1957) for young Barrow's Goldeneyes, and by Hawkins and Bellrose (*in* Kortright 1942) for young Wood Ducks. But the female merganser's call may not be audible from a distance of 40 m. Apparently female Buffleheads do not call their young from the nest (Erskine 1972).

Nesting Success

A "successful" nest being considered as one in which more than one chick hatches, nesting success for Hooded Mergansers in this study averaged 82.4% (14 of 17 nests), including six merganser–goldeneye clutches. In Oregon the nesting success for Hooded Mergansers in 55 nests in boxes averaged 80% (Morse et al. 1969). The nesting success for five Hooded Merganser nests in wooden boxes located in beaver ponds up to about 5 miles outside my study area was 60% in 1971–1972; in this study for seven Common Goldeneye nests, 57.1% in 1970–1972; and for three Wood Duck nests, 66.7% in 1970–1971. Erskine (1972) reports an average of 75 to 78% for Buffleheads in British Columbia.

In 14 "successful" Hooded Merganser nests, more than 90% of the eggs hatched (Table 5), the same as for Hooded Mergansers in Oregon (Morse et al. 1969) and for Buffleheads in British Columbia (Erskine 1972). Mean hatching failure was 0.8 egg per clutch in the 14 "successful" nests; all eggs hatched out in seven nests, while in each of the seven others, one to five eggs per nest failed to hatch (one egg contained a fully grown dead chick with beak out of shell, another contained a half-term or older chick; the other eggs were either infertile or undeveloped). Three merganser nests were unsuccessful (Table 6): one had 18 abandoned eggs; one had a dead female and 10 eggs containing almost full-term chicks; and one had 18 eggs with chicks on the verge of hatching. In the second case the box was undamaged and I surmised that the nest had been subject to predation by weasel or mink. In the third case, the female may have abandoned the clutch because she had been disturbed by my visits to the nest.

Hatching in four successful Common Goldeneye nests was more than 86% (Table 6). All eggs hatched in one nest while in each of the three

TABLE 5 — Hatching success of Hooded Merganser eggs (including only those eggs incubated by Hooded Mergansers), 1970–1972

	1970	1971	1972	Totals
Successful nests	4	6	4	14
Eggs laid	40	63	70	173
Unhatched eggs	1	2	12	15
Percent hatched in successful nests	97.5	96.8	82.9	91.3

TABLE 6 — Summary of the nesting data for Hooded Mergansers and Common Goldeneyes, Harrington, Quebec, 1970–1972

	Hooded Merganser	Common Goldeneye
Nests established	17	7
Nests successful	14	4
% successful nests	82.4	57.1
Nests lost to predation	1	0
Nests abandoned	2	2
% abandoned nests	11.7	28.6
Nests with fate unknown	0	1
Hooded Merganser eggs incubated	204	5
Common Goldeneye eggs incubated	17	45
Number of eggs in successful nests	173	37
Number of unhatched eggs	15	5
Number of hatched eggs	158	32
% hatched eggs in successful nests	91.3	86.5

others, one to three eggs per nest did not hatch (one goldeneye chick was half-term or older, the other unhatched eggs were infertile or undeveloped). Two goldeneye nests were unsuccessful: one nest with one egg was deserted before incubation and another with five eggs was abandoned to an encroaching Starling (*Sturnus vulgaris*).

In two successful Wood Duck nests 87% of the eggs hatched; the unhatched eggs of these two nests were either infertile or had not completed development. In 1971, a severe windstorm blew down a nest box containing 10 Wood Duck eggs, just 4 days before they would have hatched.

Of 10 eggs laid by Hooded Mergansers in Common Goldeneye and Wood Duck nests, nine hatched; the unhatched egg was infertile. Of 17 Common Goldeneye eggs laid in Hooded Merganser nests, 14 were hatched; one unhatched goldeneye egg had not completed development, the other was infertile, and the contents of the third are unknown. Four goldeneye eggs laid in a Wood Duck's nest were not incubated. Wood Duck eggs were not found in nests of either of the other two species of ducks.

Nest Site Fidelity

The return of waterfowl to the same nesting sites year after year has been well documented by Bellrose et al. (1964), Erskine (1961), Grice and Rogers (1965), Hochbaum (1960), and Sowls (1955).

Two of three female Hooded Mergansers banded on their nests in 1971 returned in 1972: one to the same box, the other to a box only 100 m from that occupied in 1971. In Oregon, in 1968, 64% of the female Hooded Mergansers returning to the study area nested within the same set of boxes used in the previous year (1967) and band-return data of the birds banded in 1966 and 1967 suggests that the majority of the mergansers were returning to the study area (Morse et al. 1969).

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Procedural Aspects of Moose Rumen Analysis

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Eastman, D. S. 1974. Procedural aspects of moose rumen analysis. Canadian Field-Naturalist 88: 331–335.

Abstract. Eleven moose rumen samples from north-central British Columbia were analyzed by several methods to determine the most suitable one. Separation of material retained on a 4.00-mm mesh screen provided better estimates of frequency of occurrence and quantity for plant taxa than did either separation or point-frame sampling of finer material.

Introduction

Rumen analysis is frequently used to determine diets of moose (*Alces alces*) and other ungulates, but no thorough comparative study has been made on the precision, accuracy, and efficiency of the various procedures used (Van Dyne 1968). Such an exhaustive study is probably precluded by the variations between interspecific and intraspecific diets, as well as the effects of season, age, sex, behaviorial status, range and range conditions, and variations in analytical techniques. Therefore, the realistic and practical approach is for each investigator to test several standard procedures on an initial batch of samples and select the most suitable one.

In rumen analysis, the sample is usually washed through a gang of sieves of several mesh sizes. This procedure facilitates separation of identifiable material, but can lead to error and bias since the mesh sizes chosen and the thoroughness of washing affect the amount and make-up of the material retained. Also, the few papers that examine the effects of procedure on results show important differences between species. Dirschl (1962) compared results based on three different sieve mesh openings for antelope (*Antilocapra americana*) stomach contents, and concluded that they were not affected by mesh sizes. Bergerud and Russell (1964) and Scotter (1966), however, found that the mesh sizes significantly affected the results when rumen contents of caribou (*Rangifer tarandus*) were analyzed.

The difficulties associated with screening samples can be overcome, at least for simple diets, by using methods that obviate washing, e.g. the microscopic technique of Sparks and Malechek (1968). But since screening is still commonly used, especially for browsing ungulates, and since significant interspecific differences occur, a study of errors in methods for moose rumen analysis seemed useful.

The objectives of this project were to document the fate of samples of rumen contents during analysis; to compare data obtained from different sieve mesh sizes; and to compare results determined volumetrically, gravimetrically, and by point-frame sampling. Results were evaluated by comparing frequency of occurrence and weight estimates derived from each method, with estimates based on all separated material.

Methods

Samples were collected within a 40-mile radius of Prince George, British Columbia from November 1971 to March 1972. One-liter samples of well-mixed digesta were taken from each rumen and frozen until analysis. Freezing has the advantage over formalin of preserving color (Korschgen 1969).

Prior to processing, samples were thawed completely. Oven-dried weights were determined by multiplying total wet weight (after draining to remove excess fluid) by moisture content, estimated from three subsamples. Samples were then washed through a gang of three sieves with openings of 6.35 mm, 4.00 mm, and 2.00 mm, until little or no material appeared in the discharge. Material remaining on the top two sieves, the *coarse* fraction, was separated by hand in a white enamelled tray. Separated material was measured first volumetrically by water displacement, and then gravimetrically after being oven-dried for 48 hours at 50°C.

Digesta retained by the bottom sieve, the *fine* fraction, was analyzed by two methods. First, the fragments were spread evenly over the bottom of an enamelled tray and sampled with a point frame. A slanted row of 10 pins, spaced equidistant on a wooden frame, was moved across the tray at 50-cm

intervals. At each interval, the pins were lowered and hits recorded until a total of 100 hits were obtained. After this, five subsamples were taken from the fine fraction and separated manually under a binocular dissecting microscope. Materials separated from each subsample were oven-dried and weighed. The unsampled fine material remaining on the tray was also oven-dried and weighed.

Results and Discussion

Approximately 80% of each rumen sample was lost through washing (Table 1). This represents 154 g of the one-liter samples whose mean weight was 193 g. The magnitude of this loss is probably related to whether the moose had ruminated, the foods eaten, mesh opening, and the thoroughness of sieving the samples. The digesta retained on the screens was almost evenly divided between coarse (9%) and fine (12%) fractions (Table 1). For separations, all of the coarse material was used while only 5.0% of the fine fraction, or 0.6% of the total rumen sample, was used. All the fine material, however, was used for point frame sampling.

Separated plant material was broadly classified into three categories: plant taxa, decorticated (i.e., with bark removed) twigs, and other (leaf remnants, moose hair, etc.). Usually more of the coarse fraction (34%) was identifiable to taxa than the fine fraction (23%). The relatively small proportion of identifiable material compares favorably with other moose rumen analyses (P. Karns, personal communication) and other studies. For example, Morrison (1972) identified 15%, 27%, and 31% by weight from rumen samples of mule deer, cattle, and bighorn sheep, respectively.

The largest single item was decorticated twigs comprising 58% and 73% of the coarse and fine fractions respectively. In most rumen analyses, these twigs are assumed to occur in proportion to the quantities of the identifiable components. The micro-techniques developed by Free et al. (1970) and Sparks and Malecheck (1968) to check this assumption for non-woody diets will not work for moose and other browsers because most woody material lacks the epidermal tissues commonly used in the microscopic techniques. But, since wood fiber can be keyed out usually to genus, based on anatomical features observable in macerated tissues, the assumption still may be testable; this possibility is currently under study.

Estimates for frequency of occurrence of plant taxa varied with mesh size and procedure (Table 2). With the coarse fraction, only eight (11%) of the possible 76 occurrences (sum of frequencies of occurrences for all taxa in all samples) were missed. These misses consisted mostly of small pieces from uncommon taxa, such as single needles of white spruce (*Picea glauca*). Similarly, the number of misses occurring in the fine fraction was 20 (26%) for the separation, and 53 (70%) for point frame sampling. With the latter method, most missed taxa comprised less than 10% by weight in the sample, indicating that the point analyzer was unsuited for less abundant items. Even if results from separation of both fine and coarse fractions were combined, the proportion of misses would still be approximately 3%.

The make-up of the "misses" also varied. With the coarse fraction, only one taxa (*Alectoria* spp.) was not recorded, and the frequency of occurrence of five others was underestimated. With the separa-

TABLE 1 — Fate of rumen content during analysis

Component	Oven-dried weight (grams) Coarse	Fine	Lost in washing
Identified taxa	5.6±0.6*	0.25±0.004	
Decorticated twigs	9.6±3.3	0.80±0.020	
Other material	1.3±0.3	0.05±0.0002	
Total weight separated	16.5±4.1	1.10±0.02	
Mean weight of fraction	16.5	22.4	153.9
Proportion of total sample**	9%	12%	80%

*Mean±standard error of mean. Number of samples=11 for all means except for lost material where number=8.
**Mean weight of total one-liter samples=193±14 g.

TABLE 2 — The effect of technique on estimates of frequency of occurrence in moose rumen analysis

Taxon	Total number of occurrences	Number of times missed*		
		Coarse fraction	Fine fraction	
			Weight	Point frame
Trees				
Subalpine fir (*Abies lasiocarpa*)	10	1	1	—
White spruce (*Picea glauca*)	6	3	1	6
Lodgepole pine (*Pinus contorta*)	1	—	1	—
Shrubs				
Alder (*Alnus* spp.)	2	—	—	2
Paper birch (*Betula papyrifera*)	4	—	3	4
Red-osier dogwood (*Cornus stolonifera*)	4	—	2	4
Trembling aspen (*Populus tremuloides*)	1	—	1	—
Cottonwood (*P. trichocarpa*)	1	—	1	1
Willow (*Salix* spp.)	11	—	—	5
Ash (*Sorbus* spp.)	1	—	1	—
Huckleberry (*Vaccinium* spp.)	4	1	—	3
Rosaceae	3	1	2	3
Salicaceae	6	—	2	5
Forbs				
Bunchberry (*Cornus canadensis*)	1	—	1	1
Gramineae	4	—	—	4
Pteridophytes	6	—	2	5
Bryophytes	1	—	1	1
Lichens				
Oldman's beard (*Alectoria* spp.)	1	1	—	1
Lungwort (*Lobaria pulmonaria*)	9	1	1	—
Totals (19 taxa)	76	8(11%)	20(26%)	53(70%)

*Number of samples=11 for weight data. Data for point frame based on six of these, but presented on basis of 11 for comparative purposes.

tion of fine fraction, six taxa were overlooked and eight were underestimated. With the point frame 11 of the total 19 taxa were not recorded, 5 were underestimated, and only 3 agreed with the composite information.

Estimates for amounts of taxa also varied with mesh size and procedure (Table 3). Deviations from the best quantitative estimates were least when based on separation of the coarse fraction (0.2%, sign ignored) and greatest when based on point frame sampling of the fine fraction (5.7%, sign ignored).

The discrepancies of the point frame sampling are larger than those recorded by other observers (e.g., Chamrad and Box 1964; Robel and Watt 1970). This may be a result of differences in screen sizes although Chamrad and Box (1964) did not mention the size of screens they used. Sample sizes were alike, with 100 hits recorded in all three cases. Thorough mixing of the material minimized non-randomness in the distribution of plant fragments. Therefore, the most likely reason for difference was variation in size of fragments in my samples. Perhaps analysis of even finer or ground material would overcome this difference.

Scotter (1966, p. 241) expressed surprise that many workers still use volumetric procedures. But, these methods are more suitable for field operations, being faster under most circumstances and requiring less equipment than gravimetric analyses. The disadvantage of comparing volumetric data to that expressed on a weight basis may be partly overcome since volumetric and gravimetric data are related. In this study, the following relationship was determined for dry weight of identified material (y) in grams and its

TABLE 3 — The effect of technique on estimates of amounts of taxons in moose rumens

Taxon	Best estimate		Deviation from best estimate, % basis		
			Coarse	Fine	
	Weight (g)	%	Weight	Weight	Point frame
Trees					
Subalpine fir	21.15	33	0.8	20	49
White spruce	1.26	2.0	0.2	2.9	−2.0
Shrubs					
Alder	2.23	3.5	0.1	−3.4	−3.5
Paper birch	1.56	2.5	0.1	−2.4	−2.5
Red-osier dogwood	3.45	4.5	0.1	−0.6	−5.4
Trembling aspen	2.27	3.6	0.1	−3.6	−3.6
Cottonwood	0.26	0.4		−0.4	−0.4
Willow	23.50	37	1.7	−16	−29
Ash	0.10	t*	0.2	−t	−t
Huckleberry	1.37	2.1	0.1	3.7	−1.8
Rosaceae	0.01	t			−t
Salicaceae	1.16	1.8	0.1	−1.8	−1.5
Forbs					
Bunchberry	0.2	t		−t	−t
Gramineae	0.51	0.8		0.3	−0.8
Pteridophytes	0.86	1.3		0.1	5.4
Bryophytes	t	t	−t	−t	
Lichens					
Oldman's beard	t	t	t		−t
Lungwort	4.03	6.3		0.6	−3.8
Totals	63.75	99.7			
Mean deviation (sign ignored)			0.2	2.4	5.7

*t=trace.

volume (x) in milliliters,

$$y=0.280x,$$

where R^2 (the coefficient of determination) = 0.56; $S_{y.x}$ (the standard error of the estimate) = 1.273; and n (the number of samples) = 67.

Conclusion

When rumen samples are used to determine winter food habits of moose, the most satisfactory approach appeared to be separation of digesta remaining on a sieve whose mesh opening is 4.00 mm. Analyzing material finer than this, either by separation or point-frame sampling, increased the chances of missing taxa and underestimating both frequency of occurrence and weight. Although point sampling was the fastest procedure, the resulting data were incomplete. Rumen analyses should be complemented with other independent methods of determining food habits because of the biases and sources of error in the method.

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An Unusual Escarpment Flora in Western Quebec

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Brunton, D. F. and J. D. Lafontaine. 1974. An unusual escarpment flora in western Quebec. Canadian Field-Naturalist 88: 337–344.

Abstract. Surveys during 1971 and 1972 of the cliff flora along the primarily siliceous Eardley Escarpment in Gatineau and Pontiac Counties of western Quebec revealed the presence of 25 unusual species on 10 calcareous sites. These were classified into two groups: those with affinities to the north and northwest, and those with Appalachian and southern affinities. The most notable species were *Draba cana* Rydb., *Mertensia paniculata* (Ait) G. Don, *Woodsia obtusa* (Spreng.) Torr., *Asplenium platyneuron* (L.) Oakes, *Pellaea atropurpurea* (L.) Link, *Cryptogramma stelleri* (Gmel.) Prantl, *Celtis occidentalis* L., and *Arabis canadensis* L.

Introduction

We began a search for cliff ferns in the western Quebec portion of the Ottawa-Hull District in September 1971. The most interesting species were found at several calcareous sites on the 45-mile stretch of the Eardley Escarpment in Gatineau and Pontiac Counties of western Quebec. These species would have been much more difficult to find on the Escarpment without the visual aid given by the bright orange lichen *Xanthoria elegans* (Link) Th.Fr.; it can be spotted from a considerable distance and is frequently an indicator of calcareous rock (I. M. Brodo, personnal communication 1972). For comparison purposes all of these calcareous sites were examined, as well as several non-escarpment cliffs to the northeast (Table 1). Unless otherwise stated, all species of note are represented by specimens in the DAO herbarium or the personal herbarium of D. F. Brunton.

"The Eardley Escarpment . . . fronts the Ottawa Valley and rises to a maximum of 900 feet above it on the northwestern margin" (Hogarth 1970). It runs from the northwest to the southwest, facing onto the lowland of the Ottawa Valley (Figure 1). Although generally a steep, south-facing, sparsely-wooded slope of siliceous Precambrian rock, it is broken by a number of cliffs up to 500 feet high. Several areas of marble and other calcareous rock transect it (MacDonald 1968). Occasionally streams tumble over it and a few valleys have been cut through the resistant rock, primarily along contact zones.

Depression of the land by the Wisconsin glaciation (by as much as 1000 feet (Jessop, G. A. 1969. Development of drainage nets since the post-glacial marine episode. Unpublished B.A. thesis, Carleton University, Ottawa)) resulted in the marine incursion of the Champlain Sea, which may have reached its maximum extent about 11,500 years B.P. (Before Present) (Harington 1971). The highest strandline of the Sea which has been identified along the Escarpment is at the 690-foot level (Johnson 1917).

In the western (highest) portion of the Escarpment the cliff-tops are typically covered with white and red pine (*Pinus strobus* L. and *P. resinosa* Ait.) and red oak (*Quercus rubra* L.), while the cliff-tops on the eastern (lowest) portion support a mixture of mostly deciduous trees. These include red oak, bur and white oak (*Quercus macrocarpa* Michx. and *Q. alba* L.), red maple (*Acer rubrum* L.), beech (*Fagus grandifolia* Ehrh.), bitternut hickory (*Carya cordiformis* (Wang.) K. Koch), basswood (*Tilia americana* L.), and white cedar (*Thuja occidentalis* L.). Snowberry (*Symphoricarpos albus* (L.) Blake) and blueberries (*Vaccinium* spp.) characterize the open cliff-top shrubbery. Northern bush-honeysuckle (*Diervilla lonicera* Mill.), the grasses *Hystrix patula* Moench and *Oryzopsis racemosa* (Sm.) Ricker, and the intermediate wood fern (*Dryopteris intermedia* (Muhl. ex Willd.) A. Gray) are common on the wooded cliff-tops.

The cliffs themselves are mostly exposed and support such species as white cedar and red juniper (*Juniperus virginiana* L.) on ledges and fissures, along with marginal shield fern (*Dryopteris marginalis* (L.) Gray), fragile and bulblet-bladder fern (*Cystopteris fragilis* (L.) Bernh. and

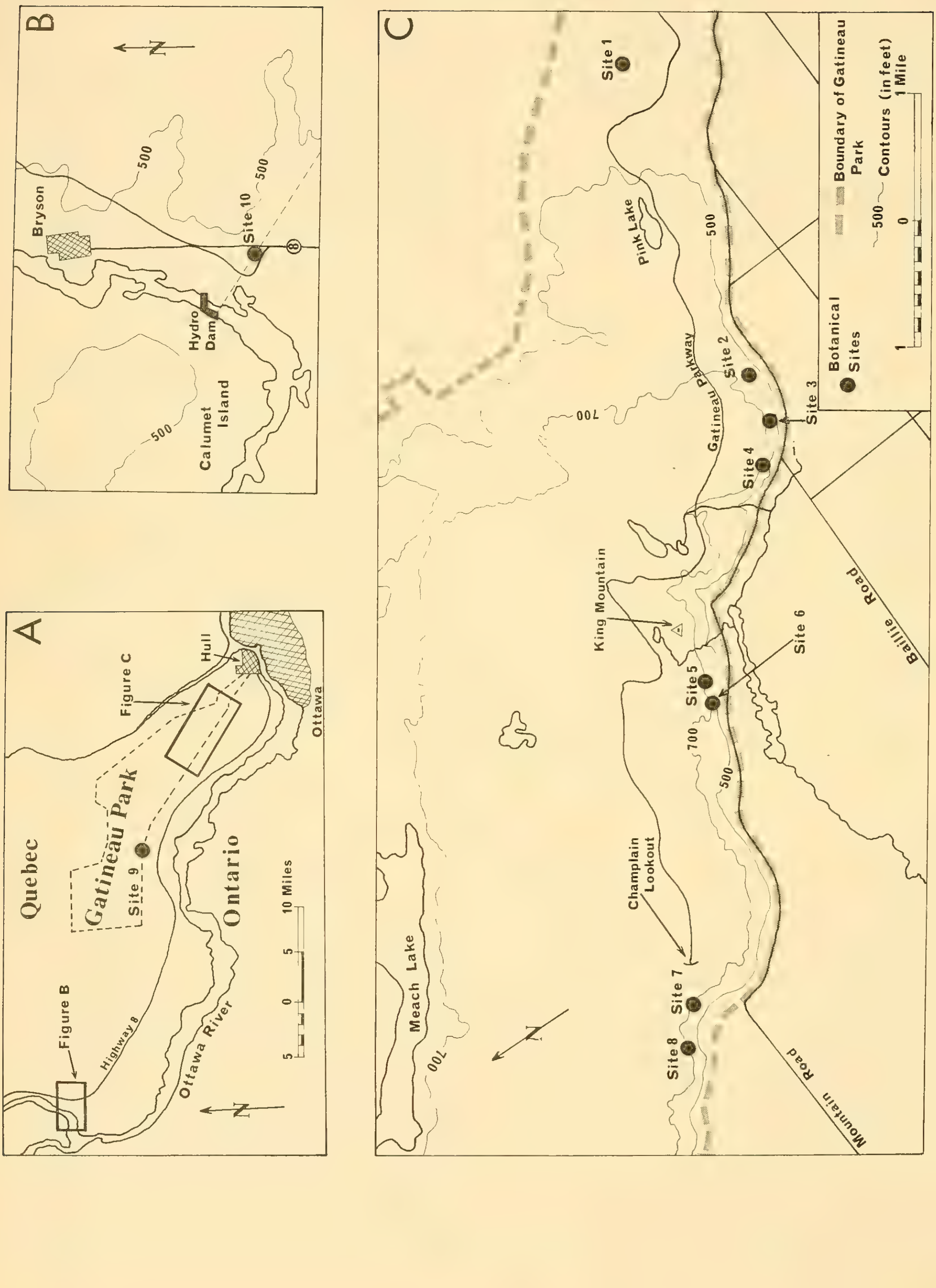

FIGURE 1. Study areas. A. Sites investigated. B. Site 10 near Bryson, Pontiac County. C. Gatineau Park sites.

C. bulbifera (L) Bernh.), rock-cress (*Arabis* spp.), bittersweet (*Celastris scandens* L.), and poison ivy (*Rhus radicans* L.).

The talus slopes vary widely, but typically are shaded with basswood and red maple and support large colonies of rock polypody (*Polypodium virginianum* L.), round-leaved dogwood (*Cornus rugosa* Lam.), *Dryopteris marginalis, Oryzopsis racemosa, Hystrix patula,* and the sedge, *Carex platyphylla* Carey.

Species with Affinities to the North and West

Cryptogramma stelleri (Gmel.) Prantl (slender cliff-brake)

Although considered to be ". . . a very rare fern in the district" (Cody 1956; Gillett 1971), large numbers were discovered along the Escarpment. It is common there on moist calcareous cliffs, being exceptionally abundant at Site 8 where it occurs continuously over 1/4 mile of cliff. It was also found at two sites near Wakefield, Quebec (Brunton 1972b). The fern is not found on marble but on siliceous rock which contains veins of calcareous material, and on earthen debris below such cliffs. The withered fertile fronds are very distinctive and are easily identified throughout the winter.

Polygonum douglasii Greene (Douglas's knotweed)

The Eardley Escarpment marks the eastern-most limit of this species in Canada (Fernald 1950; Marie-Victorin 1964). In the eastern United States it occurs locally in Maine, New Hampshire, Vermont, and New York. Along the Escarpment we have found it commonly in open sun-baked areas associated with *Vaccinium* spp., *Viburnum*

TABLE 1 — Description of sites 1–10

Site	Topography	Substratum	Dominant plant cover	Maximum elevation, in feet	No. of species with northern or southern affinities
1	Low rocky hills	Large marble boulders	Beech, sugar maple, ironwood	400	0(N) 5(S)
2	Ravine	E-facing marble wall, shaded, near stream	Sugar maple, red oak, bitternut hickory, white ash	550	0(N) 5(S)
3	Series of steep valleys through 50′ marble cliff	Rich organic soil-debris from marble cliff; marble boulders and ledges	Bitternut hickory, white oak, hackberry	600	2(N) 9(S)
4	80′ marble cliff with ledges and fissures	Pegmatite seams, calcareous debris and soil	Poison ivy, staghorn sumac, red oak, red maple	550	0(N) 6(S)
5	60′marble cliff with ledges	Ledges with debris from marble cliff	Red juniper, red oak, white oak	650	2(N) 4(S)
6	150′ cliff with ledges, 200′ talus	Syenitic gneiss and marble, calceolate veins	Red juniper, red oak, white cedar, staghorn sumac, hackberry	700	6(N) 10(S)
7	50′ cliff above 100 yd talus	Syenitic gneiss	Red and sugar maple, ironwood, bitternut hickory, beech	650	3(N) 5(S)
8	150′ cliff, boulder talus, fissures, ledges	Syenitic gneiss, calceolate veins	White cedar, red juniper, common juniper, poison ivy	700	5(N) 11(S)
9	500′ almost barren cliff	Syenite	Red juniper, white cedar, white birch, common juniper	1250	1(N) 2(S)
10	100′ marble cliff, ledges	Ledges with debris from marble cliff	Basswood, red maple, red oak	450	1(N) 4(S)

rafinesquianum (see p. 342), and occasionally fragrant sumac (*Rhus aromatica* Ait). The only station in Quebec off the Escarpment is at Oiseau Rock, Pontiac County (42°02′ N, 77°18′ W) (M. I. Moore, personal communication 1972). In Canada this species is found as far west as British Columbia (Fernald 1950).

Clematis verticillaris DC. (purple clematis)

Fletcher (1888) describes it as "Not uncommon" on King and ". . . other mountains . . ." in the Gatineau. One extant station is known (near Site 9 (J. M. Gillett, personal communication 1973)). The only other was destroyed in the late 1960s on King Mountain (Black Lake). Although common only 100 miles to the northwest in similar habitat (i.e., Algonquin Park, Ontario (Brunton 1973)) it is inexplicably rare here.

Draba cana Rydb. (whitlow-grass)

This mid-alpine and lower arctic species is fairly common in the mountains of western North America but is relict in eastern North America on a few steep cliffs (Mulligan 1971). Cody (1957) discusses the initial discovery of *D. lanceolata* (= *D. cana*) in the district (Site 6 of this study) and associated its presence with the shoreline of the late-glacial Champlain Sea. Additional evidence for this interpretation was our discovery of a station near Wakefield, Quebec at latitude 45°40′00″, longitude 75°52′05″ on October 23, 1971 (Brunton 1972b). The station appears to be near the maximum extension of the Champlain Sea up the Gatineau River Valley (Harington 1971). We found *D. cana* on particularly exposed rock areas of a calcareous nature where it presumably receives little competition from other species. We never found it on pure marble.

Arabis holboellii Hornem. (rock-cress)

It is apparently rare in western Quebec as it does not appear for that area in Marie-Victorin's (1964) account, nor does it appear on Gillett's (1958) check-list for the district. It occurs in exposed sites similar to that of *Draba cana* but shows a much greater tolerance for marble. Our plants are probably var. *retrofracta* (Graham) Rydb., which typically occurs as far south as the clay belt of Ontario and Quebec (Fernald 1950; Hultén 1968).

Potentilla arguta Pursh (tall cinquefoil)

This species is common in the district only along the Escarpment and at the Wakefield cliffs. It favors highly exposed sites.

Mertensia paniculata (Ait.) G. Don (lungwort)

At both of its stations along the Escarpment, *Mertensia* occurs on steep talus slopes of calcareous debris and soil. It is closely associated with *Draba* and is found only 1 mile west of the Wakefield *Draba* site.

These stations (first recognized by T. Reznicek) constitute the first records of the species for the Ottawa-Hull District. The collections at DAO and CAN show this species to be sub-arctic to boreal, being common southward only to the clay belt of Ontario and Quebec (see also Marie-Victorin 1964; Hultén 1968). The other stations in southern Ontario–Quebec are all located on beach-lines of the Champlain Sea (at Oiseau Rock, Pontiac County, Quebec (Moore 1972), Deux Montagnes County, Quebec, and Mallorytown Ontario). T. Reznicek (personal communication 1972) has seen a specimen from Rice Lake, Peterborough County, Ontario, which is in the Kirkfield Outlet of post-glacial Lake Algonquin (Chapman and Putnam 1966). All these records are of non-flowering, basal rosettes.

Species with Southern Affinities

Woodsia obtusa (Spreng.) Torr. (blunt-lobed woodsia)

Though probably the rarest species discovered in this survey, it is the commonest ground plant at Site 3 where a very conservative estimate would put its numbers at 700 plants (see Lafontaine 1973). The only other Canadian records of this primarily Appalachian species are two stations very close to the American border in southern Quebec (Raymond 1950; Cinq-Mars 1969). At Site 3 the plants are large, with fronds up to 14 inches long and in a continuous growth along the calcareous slope of earth near the cliff-top. It is also common along the sloping wooded lip of the Escarpment by marble outcrops and ledges, in close association with *Asplenium trichomanes*. The few small plants at Site 7 are stunted (barely 5″ high) and are in a much less shaded, less calcareous site.

Camptosorus rhizophyllus (L.) Link (walking fern)

This species is most common along the southeast end of the Escarpment and has not been recorded west of Site 8. It is exceptionally abundant on the huge, shaded boulders of the marble portion of the Site 6 talus, where many thousands of plants are found in an area approximately 20 feet by 35 feet. Similarly, thousands are found at Site 1, though over a much larger area, on the tops of the marble boulders (C. Frankton, personal communication 1972). In Quebec this Appalachian species is found only in the Ottawa and Richelieu Valleys (Raymond 1950). It was considered rare in the district prior to the discoveries of Frankton and this survey (see Cody 1956).

Asplenium trichomanes L. (maidenhair spleenwort)

Like walking fern, this species is most common at the southeast (lower) end of the Escarpment. It is particularly abundant at Sites 1, 2, and 3. It is rarer at higher elevations and farther west on the Escarpment. We did not find the plants reported by Monette (Boivin 1960) at Site 10. *Asplenium trichomanes* was always found on shaded, calcareous rock, usually in moist places. It is apparently more common in the district than was previously believed.

Asplenium platyneuron (L.) Oakes (ebony spleenwort)

A single plant was found by C. Frankton at Site 1 in November 1971. This constitutes one of only two Quebec records outside the Appalachian area of Quebec (Raymond 1950). The plant was found on a moss-covered rock below large boulders of marble. The two previous stations for the district were discovered by Frankton in Ontario, west of Ottawa, in December 1970 and October 1971. The Gatineau Park plant grows in close association with *Camptosorus* and *Asplenium trichomanes*.

Pellaea atropurpurea (L.) Link (purple cliff-brake)

Lafontaine and Brunton (1972) describe in detail the occurrence of this species along the Escarpment.[3] On October 15, 1972 we rediscovered the station near Campbell's Bay, Quebec which had been found by Monette in 1950 (Boivin 1955). Over 30 clumps were found here growing on open marble in close association with *Arabis holboellii*. They do not appear as robust as those at Site 4, which have been found with fronds over 18 inches long, but the clumps are nonetheless more robust than those pictured from Cap Tourmente, Quebec (Britton et al. 1967).

[3]In Lafontaine and Brunton (1972), four stations are numbered 1 to 4. These correspond to Sites 6, 5, 4, and 3, respectively, in this paper.

Polypodium virginianum L. (forma *acuminatum* (Gilbert) Fern.?)

The diploid form of *P. virginianum* is a good Appalachian taxon and is rare in Canada outside of Quebec (D. M. Britton, personal communication 1973). Although no cytological work is available at present to confirm our observations, we found what appears to be forma *acuminatum* at Site 8 and at the Wakefield cliff, and perhaps at Site 6 as well.

Juniperus virginiana L. (red juniper)

It is very common on the open ledges near the top of the highest Escarpment cliffs. At lower elevations, where the slopes are heavily shaded (e.g., Site 3), it is very rare or altogether absent. It is especially common at Sites 7 and 8 where large trees are found in the open fields below the cliffs as well as on them. The species is very rare elsewhere in the district and is only commonly encountered in more southerly Ontario and Quebec regions.

Carex sprengellii Dew.

This species is commonly associated with the Appalachian flora of Mississiquoi County in southern Quebec (Raymond 1950) and is rare in western Quebec off the Escarpment.

Carex platyphylla Carey

This species is found only in the Ottawa and Richelieu Valleys in Quebec (Raymond 1950). It is primarily Appalachian (Fernald 1950), and although it is common along the Eardley Escarpment, it does not occur much farther north. Moore (1972) finds it to be rare in Pontiac County, Quebec.

Carya cordiformis (Wang.) K.Koch (bitternut hickory)

It is found commonly on the lower slopes of the Escarpment in calcareous rich woods. At Site 7

two huge trees were found which both measured in excess of 20″ dbh (diameter at breast height). Although known locally from areas of thin limestone soils in the Ottawa area, it is rare in the Quebec portion of the district north of the Escarpment. Moore (1972) does not list it for Pontiac County. Raymond (1950) considers it to be typical of the flora on the ancient Champlain Sea floor.

Quercus alba L. (white oak)

Found generally in association with bitternut hickory along the Escarpment, its range is somewhat less extensive. In addition to the sites listed in Table 1, it is also found commonly on top of King Mountain, Gatineau Park. It is most common in the Appalachian areas of Quebec as well as up into the Ottawa Valley.

Ulmus rubra Muhl. (red elm)

Rarest of the last three species discussed, it seems to have a similar distribution to that of white oak (Hosie 1969). Red elm shows a preference for calcareous, rocky, somewhat exposed sites.

Ulmus thomasii Sarg. (rock elm)

This species is found commonly at the base of the Escarpment 0.3 miles east of Site 3.

Celtis occidentalis L. (hackberry)

The discovery of this species at Site 6 on the Escarpment (Brunton 1972a) was quite unexpected, as in a recent intensive survey of the species (Brunton 1971) its habitat was found to be typical of that elsewhere towards the northern limit of its range—near streams and rivers, almost invariably over limestone, and very close to the water table.

The Escarpment trees are very gnarled, and are found in small groups high up on the cliffs. They grow in very light shade or completely in the open with basswood, white oak, *Pellaea atropurpurea*, and *Woodsia obtusa*. At Site 6 (erroneously described as latitude 45°25′07″ in Brunton 1972a) some of the plants are on a rocky ledge, but most are found on the earthen slope at the lip of the Escarpment. The largest of these measures over 10″ dbh. The wide spacing between some trees and the absence of sucker growth suggests that the trees produce viable seed at least in some years.

Arabis canadensis L. (sicklepod)

Site 8 is the only known Quebec station for this primarily Appalachian species (B. Boivin, personal communication), and has been known for several years. It grows on the most exposed, calcareous ledges of the cliff-face in close association with *Draba cana*.

Rhus aromatica Ait. (fragrant sumac)

Its distribution locally is not unlike that for hackberry, being locally common along the rocky shores of the Ottawa River and, to a lesser degree, on the Eardley Escarpment. It is found commonly at several locations on the higher, more exposed sections of the cliffs. Raymond (1950) describes this as a species which occurs in Quebec only in the Ottawa and Richelieu Valleys. It gets well into the Ottawa Valley; Moore (1972) has found it in Pontiac County, Quebec.

Ceanothus americanus L. (New Jersey tea)

It is common on the most exposed, higher elevations on the western portion of the Escarpment. Another of the Richelieu–Ottawa Valley species (Raymond 1950), it is known as far west along the Ottawa River as Pontiac County, Quebec (Moore 1972). It was previously unknown for the Gatineau Park.

Viburnum rafinesquianum Schultes (downy arrow-wood)

This species is common in eastern Ontario (Soper and Heimburger 1961) but is known in Quebec only from the Ottawa Valley (Raymond 1950; Marie-Victorin 1964). It is common towards the western end of the Escarpment on exposed sites, and has been recorded fairly commonly by Moore (1972) in Pontiac County, Quebec. It is especially abundant at Site 10.

Discussion

On the Eardley Escarpment the typical Gatineau Park flora is augmented by plants of two other regions: to the north and west, and to the south. For the purposes of the discussion this latter group can be further subdivided into Appalachian and non-Appalachian components. The distribution of some of the plants discussed and their habitats leads us to believe that the Champlain Sea has played a roll in establishing the unique floristic composition of the Escarpment.

The subarctic species *Draba cana* and *Mertensia paniculata* have a disjunct distribution. Based on animal fossils, Harington (1971, 1972) suggests a boreal-subarctic environment for the Champlain Sea at the time of its maximum extent ca. 11,500 years B.P. (Prest (1970) dates the maximum at approximately 11,700 years B.P.) Illman et al. (1970) describe a fossil marine algae flora from Ottawa which suggests a similar environment ca. 10,800 years B.P. The sea was present at least as early as 12,000 years B.P. Although it is speculative, it seems very likely that at least *Mertensia* and *Draba* colonized the cliffs in this period (11,700 years B.P. to 10,800 years B.P.), as the environment then closely resembled northern areas in which both presently thrive. The occurrence of these subarctic species on only the higher cliffs may also suggest that other suitable sites were submerged during the period when environmental conditions were suitable for such colonization (assuming climatic amelioration has hindered their ability to spread).

The coming of the warm period would have caused the exclusion of those northern relicts not in optimum sites by the more competitive southern species. The non-flowering nature of *Mertensia paniculata* indicates its marginal existence and probably reflects the unsuitably warm present climate.

Eighteen of our 25 rare species have affinities to the south. The most significant are *Woodsia obtusa, Camptosorus rhizophyllus, Asplenium trichomanes, A. platyneuron, Pellaea atropurpurea, Polypodium virginianum* forma *acuminatum, Carex sprengellii, C. platyphylla,* and *Arabis canadensis*. Three additional species occur elsewhere in Quebec only in the Richelieu Valley: *Ulmus thomasii*, *Rhus aromatica*, and *Ceanothus americana*. Five more species exhibit a distribution pattern across the floor of the ancient Champlain Sea: *Juniperus virginiana, Quercus alba, Carya cordiformis, Ulmus rubra,* and *Celtis occidentalis*. One species, *Viburnum rafinesquianum*, is unknown in Quebec outside the Ottawa Valley.

We believe that the southern species survive today on the Escarpment because (1) they became established on the Escarpment during the warm period when conditions were more suitable, (2) the calcareous nature of the sites described is particularly favorable for these species, (3) they are in refugia where competition from contemporary species is minimized and, (4) their locations permit maximum advantage from the south orientation of the cliffs (i.e., a warmer, more ''southern'' micro-climate).

Acknowledgments

Our thanks go to Mr. Joe Dafoe of Ottawa for his important help with the geology of the Escarpment. Mrs. M. I. Moore of the Petawawa Forest Experiment Stations kindly gave us floristic data from Pontiac County, Quebec. Dr. D. M. Britton of the University of Guelph supplied valuable information and suggestions regarding ferns. Mr. Tony Reznicek of the University of Toronto was very helpful in the field and an important source of information. Several members of the Canada Department of Agriculture's Plant Research Institute (Dr. B. Boivin, Mr. W. J. Cody, and Mr. G. Mulligan) were generous in assistance with identifications and literature. Special thanks go to Dr. C. Frankton of the Plant Research Institute for his most constructive criticism of an early draft of the manuscript; in addition to that and a significant amount of field data, he provided constant support and encouragement.

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Notes

The Orchid *Listera australis* Rediscovered in Ontario

Abstract. New sites of *Listera australis* Lindley, a rare orchid, are reported from Prescott and Simcoe Counties, Ontario. The habitats at these sites are described and the discoveries are discussed in relation to the history, range, and flowering time of this species in Canada.

Although well known and sometimes locally frequent in the southeastern Atlantic and Gulf states of the United States of America, *Listera australis* Lindley (southern twayblade) is rare in the northeastern states. It is very rare in eastern Canada, where it was first collected from the Mer Bleue bog, in Carleton County, Ontario, in 1893 (Fletcher, CAN 116993, TRT 15703). Nine years later it was collected again from the same bog (Macoun, TRT 15701). Apparently the species was not seen again in Ontario for 71 years, although it was found farther east in Canada: in Quebec near Montreal (Mousley 1940), near Hatley (J. H. Soper, personal communication), and near Quebec City (Greenwood 1962; Doyon and Cayouette 1969); in Nova Scotia near Inverness on Cape Breton Island (Whiting 1971). Canadian occurrences are mapped in Figure 1.

Following a suggestion by D. R. Gunn that the Alfred Bog would be a likely habitat to search for this orchid in Ontario, the senior author, accompanied by P. M. Catling and S. M. McKay, visited that extensive bog in Prescott County on 9 and 10 June 1973. We found over 40 flowering plants of *Listera australis* rooted in deep wet *Sphagnum* in sheltered openings of the black spruce – tamarack bog (Figure 2). The openings that we examined varied from about 200 square meters (240 square yards) to about ten times that area. Shrubby growth in the *Sphagnum* of the openings included *Ledum groenlandicum, Gaylussacia baccata, Kalmia polifolia*, and dwarf plants of *Chamaedaphne calyculata*. Many small plants of *Smilacina trifolia* and *Vaccinium oxycoccos* were in flower, and we noticed some *Carex trisperma* and *Carex pauciflora*. The *Listera australis* plants usually grew singly, separated by at least a meter or two, near the

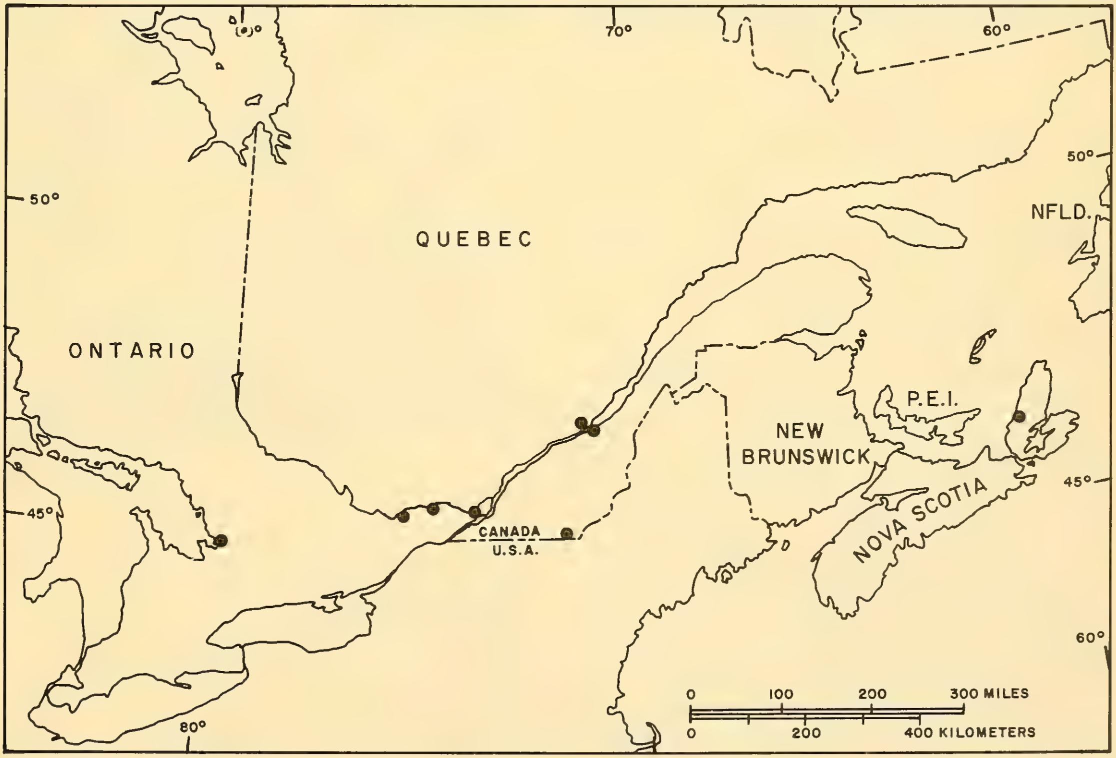

FIGURE 1. Known occurrences of *Listera australis* in Canada.

FIGURE 2. One of the openings in the Alfred Bog, Prescott County, where *Listera australis* was found on 9 June 1973. Photograph by P. M. Catling.

FIGURE 3. Inflorescence of *Listera australis*. Photographed in Alfred Bog, Prescott County, by P. M. Catling on 10 June 1973. Three times natural size.

edges of the smaller openings, or in the more extensive openings they could be found around the borders of drier hummocks which supported small spruce and tamarack trees. Figure 3 shows the inflorescence of one of the *Listera australis* plants.

The openings examined are included in an area of about 0.65 square kilometers (0.25 square miles), located at 45°30′ N and 74°49′ W, 8.2 kilometers (5.1 miles) southeast of Alfred. Inspection of aerial photographs suggests that this area contains only a small fraction of the suitable habitat within the large bog. More extensive and intensive exploration of the bog would probably reveal many more of the twayblades.

After hearing from Mr. Catling about the discovery near Alfred, A. A. Reznicek initiated a trip to a bog in Matchedash Township, Simcoe County. On 17 June 1973 the junior author accompanied Mr. Reznicek and J. R. F. Wiseman to this bog, located at 44°51′ N and 79°36′ W, 3.2 kilometers (2.0 miles) south of Severn Falls. After more than 2 hours of concentrated search we were able to distinguish 15 plants of *Listera australis* from their companion plants (Figure 4). This station represents a 320-kilometer (200-mile) westward extension of the known Canadian range of the species, and an addition to the orchid flora of the Western Great Lakes Region as treated by Case (1964).

The Simcoe County site maintains the ecological preference of this species in eastern Canada. As at sites farther east, the habitat here is basically a black spruce – tamarack bog. This Matchedash bog is only about 1.0 hectare (2.5 acres) in extent, and within this area the orchid occurs only in *Sphagnum* of irregular but fairly well-defined "openings" in the fragmented tree cover.

FIGURE 4. *Listera australis.* Drawn by A. Geras from a fresh plant taken in Matchedash Township, Simcoe County, on 17 June 1973. Natural size.

No more than four plants of *Listera* were seen in any one of these small open areas. The twayblades were well obscured by a loose cover of *Woodwardia virginica, Andromeda glaucophylla, Smilacina trifolia, Chamaedaphne calyculata,* and *Vaccinium* species.

Our specimens of *Listera australis* from Prescott and Simcoe Counties are preserved in the herbarium of the University of Toronto (TRT 176890 and 177544 respectively).

A survey of Canadian records of this orchid indicates that the best time to see it in full flower is normally the second week of June. But it has been seen in flower as early as 1 June and as late as 21 June.

We thank those who suggested searching these bogs for this orchid, and we are grateful to our co-discoverers for field companionship and suggestions for the improvement of our manuscript.

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Addendum: On 8 June 1974 the authors and S. White discovered a third modern Ontario station of *L. australis* in Muskoka. Twenty-three plants in full flower were found in a bog in Muskoka Township, 4.3 kilometers (2.7 miles) west of Gravenhurst at 44°55′ N and 79°26′ W. Vouchers will be sent to CAN, DAO and TRT. This Muskoka site is 15 kilometers (9.4 miles) northeast of the Simcoe County site already described.

A Northern Range Extension for the Northern Bog Lemming, *Synaptomys borealis borealis* (Richardson)

As part of a study on the northern red-backed vole, *Clethrionomys rutilus*, from May 1971 through September 1973 approximately 75,000 trap-nights were run with snap-traps in the vicinity of Inuvik, Northwest Territories. During this trapping, four specimens of the northern bog lemming, *Synaptomys borealis*, were taken and have been identified as *S. b. borealis* (confirmed by C. G. van Zyll de Jong) and deposited in the National Museum of Natural Sciences (NMC).

The first specimen was a female taken on 27 May 1971 (NMC 42571), the second was a male collected on 30 August 1971 (NMC 42572), and the last two were males trapped on 26 June 1972 (NMC 42573–74). All specimens were taken within 1 kilometer of each other (68°20′ N, 133°38′ W) approximately 3.5 kilometers east and 3 kilometers south of Inuvik. No other specimens were secured although the same areas were trapped later in 1972 and again in 1973.

The previous northernmost record for *S. b. borealis* was the collection made at Fort Franklin, Northwest Territories, by J. Richardson (1828. Short characters of a few quadrupeds procured on Captain Franklin's late expedition. Zoological Journal 3(12): 516–520); this was also the first record of the species. The present collection is from 360 kilometers north and 448 kilometers west of Fort Franklin. The previous northernmost record for *S. borealis*, and for *Synaptomys*, was for *S. b. dalli* from Old Crow, Yukon Territory (Youngman, P. M. 1964. Range extensions of some mammals from Northwestern Canada. National Museum of Canada Natural History Paper Number 23. 6 pp.). The present collection is from 81 kilometers north of the latitude of Old Crow.

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A Northern Range Extension for the Bushy-tailed Wood Rat, *Neotoma cinerea* (Ord)

The bushy-tailed wood rat, *Neotoma cinerea*, has been recorded as far north as Lapie River, Mile 132 Canol Road, near the junction of the Pelly and Ross Rivers, Yukon Territory (Rand, A. L. 1945. Mammal investigations on the Canol Road, Yukon and Northwest Territories, 1944. National Museum of Canada Bulletin 99. 52 pp.). On 27 July 1973 a bushy-tailed wood rat was seen and photographed (Figure 1) at "Sven Lake," Northwest Territories (65°23′ N, 131°16′ W). This site is on a tributary of the Arctic Red River in the foothills of the Mackenzie Mountains approximately 205 kilometers west of Norman Wells, Northwest Territories. This sight record is approximately 350 kilometers north of the Lapie River collection.

FIGURE 1. Bushy-tailed wood rat at "Sven Lake." Photo by J. N. Jasper.

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Organochlorine and Mercury Residues in Gulls' Eggs from Western Ontario

Abstract. Organochlorine (DDE, dieldrin, PCBs) and mercury residues in eggs of Herring Gulls (*Larus argentatus*) and Ring-billed Gulls (*L. delawarensis*) from western Ontario are reported. Concentrations in wet weight (ppm) of DDE and PCBs approximate levels reported from aquatic birds in the Canadian prairie provinces. Mercury levels in both species are lower than those reported from heavily polluted waters.

Introduction

Recently Vermeer and Reynolds (1970) reported the organochlorine residues in aquatic birds on the Canadian prairies. They stated that organochlorine residues DDE and dieldrin reflect food habit differences between species. Stimulated by the above paper, along with the report of Hays and Risebrough (1972) which suggested chemically induced congenital abnormalities similar to an observation of polydactyly in the Ring-billed Gull (*Larus delawarensis*) on Granite Island in Black Bay, Lake Superior (Figure 1) (Ryder and Chamberlain 1972), I collected eggs of Herring Gulls (*Larus argentatus*) and Ring-billed Gulls from four nesting colonies in western Ontario to determine organochlorine and mercury residues in these heretofore unsampled populations (Figure 1).

Study Area and Methods

Figure 1 and Table 1 show, respectively, the location and number of eggs of each species collected in 1973. One egg was taken from each nest. Within 24 hours after collection eggs were shipped by air to Ottawa for analysis of entire contents of intact eggs. Samples were pooled for analysis to reduce costs.

Analyses for organochlorines and mercury, and measurements of moisture content were done by Dr. L. M. Reynolds of the Ontario Research Foundation by methods outlined in detail by Reynolds (1969) and Vermeer (1971), respectively. I have restricted consideration here to DDE, dieldrin, and PCBs. Vermeer and Reynolds (1970) found that residue levels of these chemicals in the laying birds' tissues may be predicted when known from eggs.

Results

Major differences in residue concentrations between the two species are found in DDE and PCBs. Tables 2 and 3 show that Herring Gulls' eggs contained more DDE and PCBs than Ring-billed Gulls'. Dieldrin concentrations are similar in both species of gulls and fall within the ranges reported by Vermeer and Reynolds (1970). The Ring-billed Gull eggs from Gravel Island, however, show higher levels than any of the other samples.

Mercury levels in the eggs fall within the range of those recorded by Vermeer (1971) although intercolony differences in this study are not apparent (Table 4). It is interesting to note the levels of mercury in Clay Lake (near Kenora, Ontario) Herring Gull eggs (Vermeer et al. 1973) are higher than those sampled for this study. It is unlikely, in relation to the conclusions of Vermeer et al. (1973) that hatching success of the Herring Gulls' eggs sampled here is affected by recorded mercury levels. Although mercury levels in the Ring-billed Gulls from Lake Superior are similar to those of the Herring Gulls from the same location, nothing can be stated yet about the current effects of mercury on the former species since it appears the threshold levels of mercury are interspecifically different (Vermeer et al. 1973).

It is possible that both gull species in northern Lake Superior are differentially utilizing fish and other aquatic organisms in their diets before the nesting season, but that mercury residues in the environment are currently too low to indicate interspecific differences in feeding habits, as was found for Caspian Terns (*Hydroprogne caspia*) and Common Terns (*Sterna hirundo*) near Lake Winnipeg, Manitoba (Vermeer 1973).

TABLE 1 — Collection of gull eggs from colonies in western Ontario, 9 May 1973

Colony location	Number of Herring Gull eggs collected	Number of Ring-billed Gull eggs collected
Granite Island*	8	9 (1 egg broken and contents lost during shipment)
Buck Island	11 (3 eggs broken and contents lost during shipment)	—
Silver Islet	10	—
Gravel Island	—	**12 (2 eggs broken and contents lost during shipment)

*Granite Island has both Herring and Ring-billed Gull colonies. All other islands are single-species nesting colonies.

**Ten Ring-billed Gull eggs from Gravel Island collected on 9 May 1973 were all destroyed in shipment from Thunder Bay to Ottawa. Repeat collection of 12 eggs was made on 11 June 1973.

TABLE 2 — Mean wet weight (ppm) of organochlorine residues in composite samples of Herring Gull eggs from western Ontario, 1973

Sample location	Number of eggs in pooled sample		Moisture, %	Organochlorines, ppm		
				DDE	Dieldrin	PCB
Granite Island	Sample 1	4	77.0	20.9	0.17	42.1
	Sample 2	4	74.8	26.5	0.37	56.1
Buck Island	Sample 1	4	76.4	15.9	0.37	44.1
	Sample 2	4	75.9	33.9	0.39	54.7
Silver Islet	Sample 1	5	76.1	22.1	0.33	40.6
	Sample 2	5	75.5	31.5	0.54	64.1

TABLE 3 — Mean wet weight (ppm) of organochlorine residues in composite samples of Ring-billed Gull eggs from western Ontario, 1973

Sample location	Number of eggs in pooled sample		Moisture, %	Organochlorines, ppm		
				DDE	Dieldrin	PCB
Gravel Island	Sample 1	5	75.3	5.40	0.63	30.4
	Sample 2	5	73.8	7.65	0.67	25.8
Granite Island	Sample 1	4	75.3	5.90	0.44	28.4
	Sample 2	4	76.1	3.10	0.47	16.3

TABLE 4 — Mean wet weight (ppm) of mercury in composite samples* of Ring-billed Gull and Herring Gull eggs from western Ontario, 1973

Sample location	Mercury, ppm	
	Herring Gull	Ring-billed Gull
Granite Island	0.40	0.52
	0.44	0.45
Buck Island	0.62	—
	0.41	—
Silver Islet	0.50	—
	0.56	—
Gravel Island	—	0.49
	—	0.75

*Samples are the same as those given in Tables 2 and 3.

TABLE 5 — Thickness (mm) of Ring-billed Gull eggs on Granite Island, Black Bay, Ontario, 1971

	Mean thickness	Standard deviation	Sample
Addled eggs	0.300	0.032	22
Hatched eggs	0.294	0.027	29

TABLE 6 — Shell weight of Ring-billed Gull eggs

Year	Location	Sample size	Weight (g)
1905	Snake Island, Georgian Bay, Ontario	22	3.3±0.35
1928	Gull Island in Georgian Bay, Ontario	12	3.3±0.36
1930	Gull Island and Kingston, Ontario	12	3.7±0.28
1931	Tiny Island in Georgian Bay, Ontario	6	3.3±0.20
1932	Muggs Island, Toronto Harbour, Ontario	3	3.1±0.30
1937	Tiny Island, Georgian Bay, Ontario	11	3.8±0.20
1938	Tiny Island, Georgian Bay, Ontario	6	3.8±0.37
Total		72	3.5±0.38
1973	Granite Island, Ontario	9	3.7±0.28
1973	Gravel Island, Ontario	7	3.8±0.31

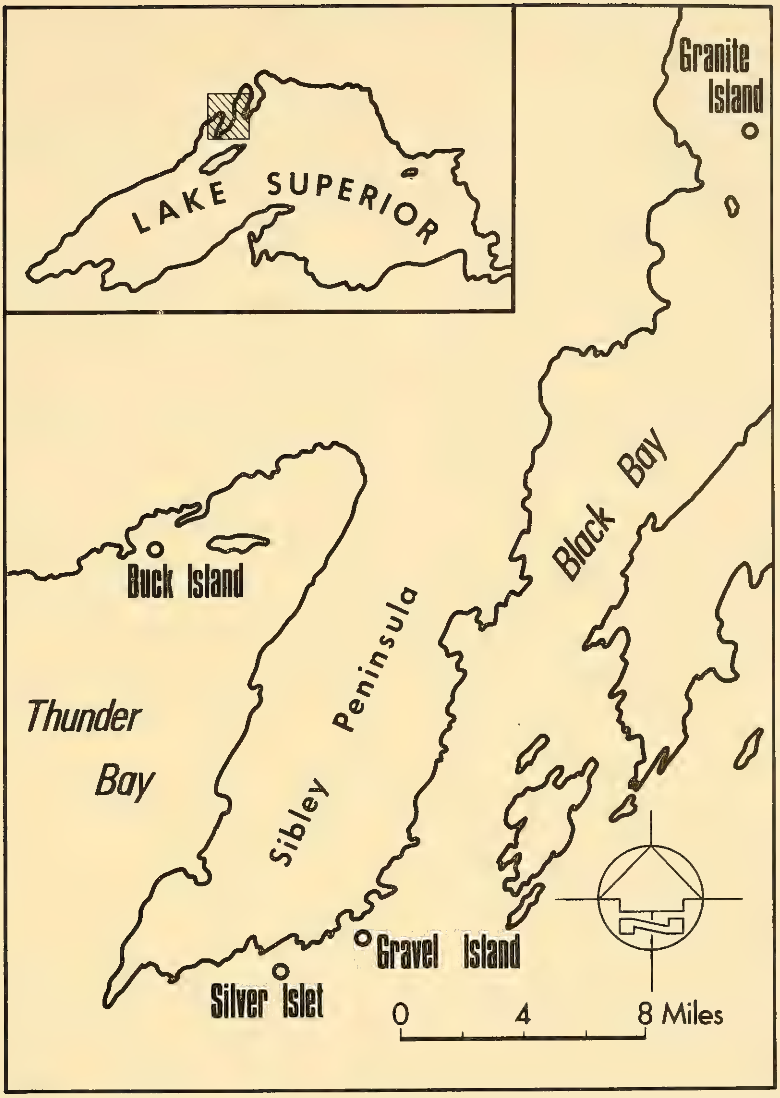

FIGURE 1. Islands in Black Bay and Thunder Bay, western Ontario where Herring Gull and Ring-billed Gull eggs were collected in 1973.

Discussion

The results of this initial survey of the organochlorine and mercury residues suggest that food habit differences between Herring Gulls and Ring-billed Gulls which nest in northern Lake Superior exist prior to egg-laying. Residues are within the ranges reported by Vermeer and Reynolds (1970), Vermeer (1971), and Vermeer et al. (1973) with no apparent deleterious effects on the reproductive performance of the two species. Certainly the contamination of eggs with DDE is below that reported by Keith (1966) for Herring Gulls to expect any effect on reproductive success.

During the 1971 nesting season on Granite Island we found the shell thickness of 22 addled Ring-billed Gull eggs (i.e., those containing different-aged embryos at various stages of decomposition) was similar ($P > 0.05$) to the thickness of 29 hatched eggs in that year (Table 5). According to data and discussions on organochlorine residues in dead-embryo eggs and live-embryo eggs (Keith 1966) and the apparent relationship between DDE and eggshell thinning (Vermeer and Risebrough 1972), I would expect a greater than observed difference in egg-shell thickness between addled and hatched eggs if organochlorines were important

factors currently affecting hatching success. Egg mortality on Granite Island seems more related to predation by Herring Gulls, Ring-billed Gulls, and Common Crows (*Corvus brachyrhynchos*).

Other suggestive evidence for a general lack of pesticide effects on the eggs of Ring-billed Gulls appears in Table 6. The pre-DDT-collected eggs (i.e., before 1945) show a mean shell weight equivalent to those from Granite and Gravel Islands. Since it is well established from experimental biochemical evidence that DDT, DDE, and dieldrin can cause a decrease in eggshell weight (Ratcliffe 1970), I conclude the northern Lake Superior Ring-billed Gulls are not affected by these pesticides. Additionally, data show the Herring Gulls here considered carry much lower mercury residues than the nearby Clay Lake population whose hatching success is apparently unaffected by mercury (Vermeer et al. 1973).

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Great Black-backed Gulls Feeding on Live Eels

Although dead eels are probably eaten by gulls, the capture of live eels is difficult for these birds and has not been reported. Diving in the manner of a tern, which is the method of capture reported here, "is seen only occasionally" in the Herring Gull (*Larus argentatus*) (Tinbergen, N. 1963. The Herring Gull's world. Collins, London). While Tinbergen also reports this behavior in the Black-headed Gull (*L. ridibundus*), Iceland Gull (*L. glaucoides*), and the Glaucous Gull (*L. hyperboreus*), it has not been reported in the Great Black-backed Gull (*L. marinus*).

During the period from May 9 to 14, 1973, I watched Great Black-backed Gulls on five occasions attempting to catch live American Eels (*Anguilla rostrata*) in shoal waters. Observations were made in the county of Antigonish, Nova Scotia, in the brackish waters of the estuary of the Rights River. The eels were swimming against the current during low tide in 2 to 5 feet of water. Periods of feeding activity by the gulls lasted about 10 to 15 minutes.

It was usual for a gull to circle 50 to 100 feet above the eels then partially fold its wings and drop to 5 or 10 feet above the surface, break its fall by opening its wings, then plunge into the water almost to the point of complete submersion. The dives resulted in success infrequently. The eels caught varied in length from an estimated 10 to

24 inches. Gulls grasped the eels in the middle of the body and simply held them firmly in their bills while the slippery prey twisted about.

The gulls did not attempt to swallow the eels at the point of capture. Rather they attempted to fly landward with them. Sometimes they lost their prey before becoming airborne (within moments of capture) but more often they flew successfully to a nearby exposed mud flat. There was no attempt to swallow the eel in flight. One gull while in flight was seen to drop its victim because of harassment by five other gulls.

When on the mud flat a gull would usually drop the eel and then immediately grasp it by the head and proceed to swallow it. Eels of approximately 12 inches were swallowed readily, but to swallow a larger one often required more than 1 minute, especially when the process was slowed down by one or more other gulls' grasping the tail of the eel while its rightful owner was working at the other end.

Although numerous Herring Gulls frequented the estuary at this time, not one was seen to attack eels. Common Crows (*Corvus brachyrhynchos*) occasionally located live eels on exposed mud flats but were never seen to swallow one. On many occasions during spring and early summer I have observed Bald Eagles (*Haliaeetus leucocephalus*) searching for and locating live eels that had apparently become stranded on the exposed mud flats in the estuary. After alighting they approached their victim by hopping awkwardly toward it. The bird would then grasp the eel with its talons and either fly off with the prey, presumably to the nest site, or as often to a stump or hummock to devour it. This was accomplished, not by swallowing whole, but by ripping it apart with its bill.

Observations of Great Black-backed Gulls suggest that diving behavior is more widespread within the Laridae than previously noted and is seen only infrequently because "its occurrence depends on special conditions which occur only rarely" (Tinbergen 1963). The occurrence of living eels close enough to the surface for capture is likely a rare occurrence except in local areas such as the above. Here eels concentrate in shallow waters to feed on offal.

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A Horned Puffin, *Fratercula corniculata*, near Coppermine, Northwest Territories

On 24 August 1973, a puffin was sighted on the water near the landward end of Basil Bay, approximately 30 miles northwest of Coppermine, Northwest Territories. The bird flew away, but was later collected by two local hunters and brought to me. It was identified as an adult male Horned Puffin and a skin was made of it, which now is in the collection of the National Museum of Natural Sciences. No other individuals of this species were seen during our stay. After questioning several of the local hunters, we found that this species had not previously been seen in the area.

This species breeds in northeastern Siberia and in coastal Alaska south to Forrester Island. Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.) listed this species as hypothetical in Canada with sight records from the northern coast of Queen Charlotte Islands but he has advised me that since then two specimens have been collected (1971) by Dr. Spencer Sealy from Langara Island, Queen Charlotte Islands, British Columbia. The present record represents the easternmost known point of occurrence.

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White-faced Ibis Photographed in British Columbia

The White-faced Ibis (*Plegadis chihi*) is considered a casual straggler to Canada, being recorded only in British Columbia (W. E. Godfrey. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.). The most recent verified record was an immature bird collected at Sardis, near Vancouver, in 1902. Two other unsubstantiated accounts were also made in the southwestern part of the province at about the same time.

On May 9 and 12, 1968, I observed two White-faced Ibises, approximately 15 miles east of Cranbrook and about 500 miles east of the previous record. The birds were about 20 inches tall, with dark-colored, long legs and distinctly decurved brown-black bills. Plumage was brown with an iridescent sheen, except for conspicuous white markings near the base of the bills. The birds were seen together in a wetland habitat, locally known as Wasa Sloughs, along with a variety of migrating waders and waterfowl. I photographed one of the birds and a print is now accessioned as PDF 257 in the photoduplicate file of British Columbia vertebrate records at the British Columbia Provincial Museum.

Ibises may have occurred previously in this part of the province. Mr. W. G. Smith, former regional wildlife biologist at Cranbrook, told me that several district residents reported seeing birds that may have been ibises. Although these reports were not verified, it is possible that the species may occur more frequently than was previously thought.

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Early Embryonic Mortality in a Herring Gull Colony in Lake Ontario

During a survey of breeding success of fish-eating birds on the lower Great Lakes in 1972, serious reproductive failure was observed among several colonies of Herring Gulls, *Larus argentatus*, in Lake Ontario (Gilbertson 1974). In 1973, a study was undertaken to determine whether poor hatching success caused by the death of embryos during incubation was a significant factor causing failure.

Seventy Herring Gull nests were numbered on May 6 in the central grass area of Scotch Bonnet Island (43°54′ N, 77°32′ W) in the eastern half of Lake Ontario, and a table of random numbers corresponding to the nest numbers was compiled. One egg in each of these numbered nests was randomly selected when the clutch size reached three, marked with a felt-tipped pen, and replaced in the nest. During each of five subsequent visits at approximately 5-day intervals, all the numbered nests were examined, the condition of the nests noted, and the marked egg from each of eight nests collected. These eight nests were randomly selected before the visit by taking eight numbers from the table of random numbers. If the marked egg happened to be missing from one of these eight nests, the nest corresponding to the next number in the table of random numbers was chosen.

The eight eggs, collected on each visit, were placed in a commercial egg box and transported in a warm container to the laboratory. The eggs were opened by cutting the girth with a knife. Movement of the heart was used as the criterion of whether the embryo was alive or dead. The age of the embryo was determined by reference to the work of Maunder and Threlfall (1972), who aged embryos of the Black-legged Kittiwake, *Rissa tridactyla*, which has a similar incubation period to that of the Herring Gull.

Amongst the 70 nests which were numbered on May 6, 19 did not contain eggs during the period of the study. A further six contained one or two eggs. In only three nests, which contained three eggs, was the marked egg lost before collection. Of the 40 three-egg clutches from which one egg was collected, 32 clutches were complete by May 11, the remainder by May 16.

Figure 1 shows the results of the study. Amongst the 40 eggs sampled, eight (20%) had embryos which died during their first 7 days. No embryos were found to have died between the 7th and the 25th day of age. Amongst

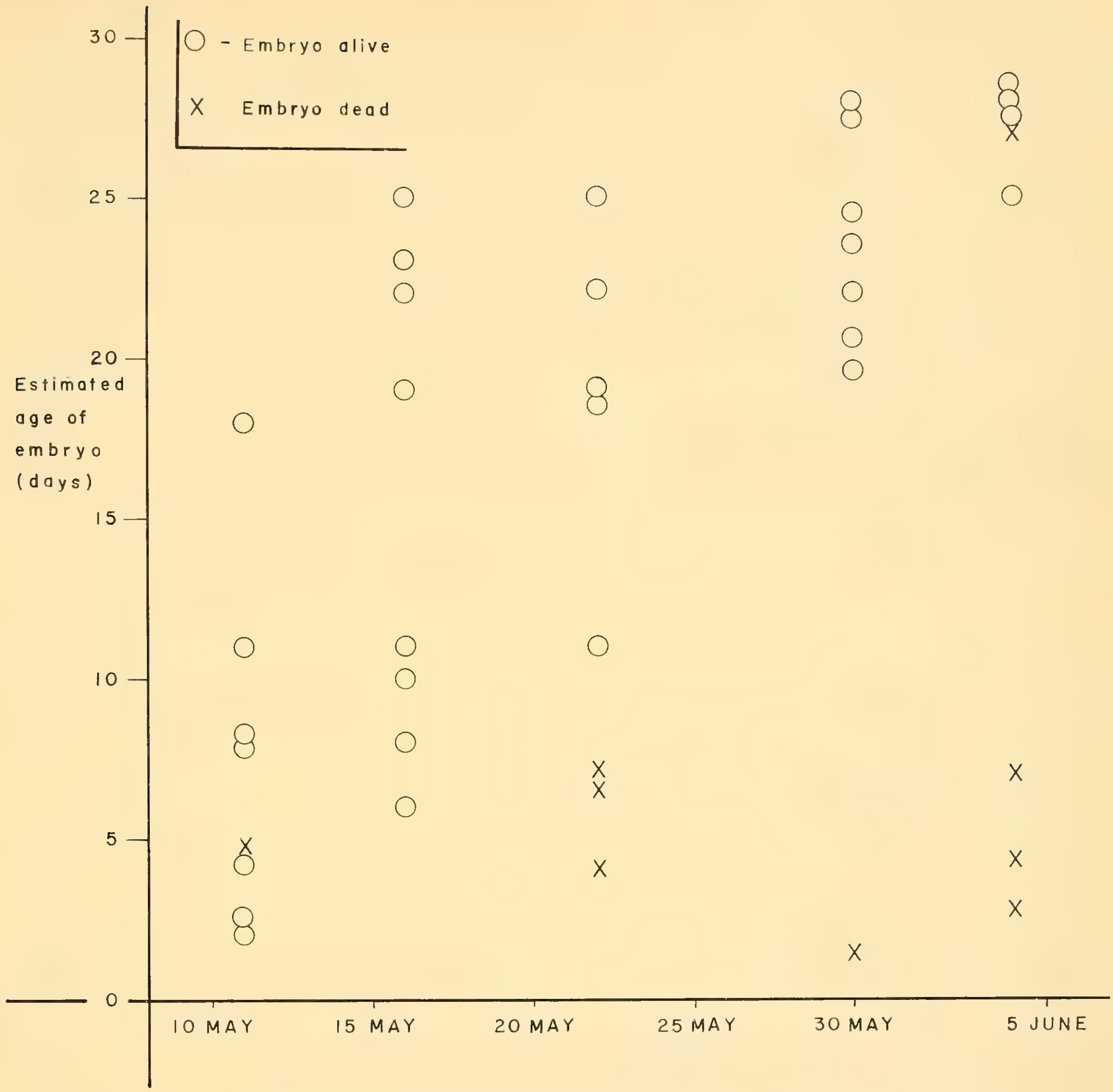

FIGURE 1. Distribution of estimated age of dead and live embryos.

the six embryos of hatching age, one died after making the initial hole in the shell. Thus the total mortality observed by this technique was 22%. Since eggs were not incubated to term, the mortality which may have occurred at hatching has not been estimated. The total hatching failure for the complete incubation period has been estimated in another study (Gilbertson and Hale 1974). Though there appears to be a greater proportion of dead eggs among those sampled later, all the dead eggs had been laid by 11 May. Since the sampling was randomized there is no indication that eggs laid later show greater mortality.

There are several estimates of embryonic mortality or of the proportion of eggs which fail to hatch in colonies of Herring Gulls. Kadlec and Drury (1968) estimated the number of dead eggs to be 3% in the first three weeks of age in two colonies on the eastern seaboard of the United States. Harris (1964) estimated that 7.3% of the eggs laid in a study area on the island of Skomer in Britain showed no signs of development or contained a dead embryo. Paynter (1949), working on the colony on Kent Island, New Brunswick, found 4.5% of the eggs in three-egg clutches died prior to pipping, and that a further 1.9% died after pipping of the eggshell. Paludan

(1951) estimated 6% total mortality among eggs laid in the Danish colony he studied. These estimates are in contrast to those found in Lake Michigan by Keith (1966), who found that 30% of the eggs in the Green Bay colony died, and by Ludwig and Tomoff (1966), who found 17% of the 235 eggs which they examined contained dead embryos. Thus the three studies in the Great Lakes have shown a higher incidence of embryonic death than any of the studies carried out in four other locations. The hypothesis that the embryonic mortality in the Great Lakes is equivalent to that of other regions can be rejected at a probability level of 0.029 (one-tailed) (Mann-Whitney two-sample U-test (Siegel 1956)).

This study has shown that early mortality during incubation is at least 20% in this colony in Lake Ontario and that this is one factor contributing to the observed reproductive failures.

We are indebted to Dr. R. W. Risebrough for initiating this project and to Dr. G. E. J. Smith for assistance in designing the sampling procedure and in the analysis of the data.

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Characteristics of the Breeding Failure of a Colony of Herring Gulls on Lake Ontario

Introduction

In 1972, an extensive study was undertaken on the distribution and severity of reproductive failures in colonies of Herring Gulls (*Larus argentatus*) on the lower Great Lakes (Gilbertson 1974). The 1972 study showed that the failure of the Herring Gulls was related to their contamination with organochlorine substances and further, that there was an inverse relationship between DDE and eggshell thickness. Colonies on Lake Ontario had the thinnest eggshells, the highest residues, and raised very few fledged young. The Herring Gull was shown to be a valuable monitor species in the Great Lakes since the residues accumulated by the adult birds appear to reflect those in the local environment. The Great Lakes environment appears to be the most polluted environment, from a toxicological standpoint, in Canada and thus measurement of the severity of the biological effects caused by toxicants can aid in the assessment of the present condition of the different lakes.

In 1973 the characteristics of the breeding failures were investigated at a colony which had exhibited very poor breeding success in 1972. The colony was on Scotch Bonnet Island, situated in Lake Ontario

(43°54′ N, 77°32′ W). Concurrent with this reproduction study was an investigation of embryonic mortality in the same colony, which showed that 20% of the eggs laid died within the first week of incubation (Gilbertson and Hale 1974).

Nests on the stone periphery of the island were used in this study since the nests in the central grass area were being used for the study of embryonic mortality. The nests and eggs were numbered so that the details of the success of the individual pairs could be assessed. At hatching the chicks were banded for subsequent identification but since no retaining wire was erected round the island the fate of chicks was difficult to assess satisfactorily. The island was visited about once every 5 days from April 30 until July 15, 1973.

Results and Discussion

There was one main period of egg-laying which lasted from 30 April to 22 May. There was, however, a prolonged subsequent period of renesting which continued at least until the last visit on July 15. The first nesting period of Herring Gulls has sometimes been found to be more successful (Paynter 1949), though other studies have found no difference (Kadlec and Drury 1968). For the purposes of this analysis the two periods are considered separately and are referred to as the first and second periods. Table 1 shows the hatching success of eggs during the two periods by clutch size. The mean number of eggs hatched per egg laid is particularly low, with a mean hatching success of only 17% in the first period and 12% in the second period.

Table 2 shows that the main cause of the poor hatching success was the disappearance of eggs. This disappearance was characterized by loss of the whole clutch and by destruction of the nest. Though lake levels were extremely high in 1973, Scotch Bonnet was sufficiently far above the high-water level that nest loss could not be accounted for by flooding or storm action. The other main causes of the failure to hatch were the death of the unhatched chick or embryo and shell breakage.

TABLE 2 — Egg loss prior to term during both laying periods

Category	Number	Percent of total marked
Disappeared	82	34
Dead	72	30
Broken	22	9
Out of nest	6	2

Loss of the whole clutch and the nest being a characteristic of the nesting failure, the data on hatching success have been further analyzed to determine the hatchability in nests in which at least one egg reached the pipping stage. There were 32 nests in this category, with a total of 88 eggs. Forty (45%) of these eggs hatched, but 19 (22%) died prior to term, 14 (16%) died after pipping the shell, the remaining 17% disappeared, were found broken or cold and out of the nest. In addition three chicks entered the study area from outside and were thus banded.

Thirty-eight of these 43 banded chicks died prior to fledging. The highest mortality, 32 chicks, was during the first 9 days but two dead chicks were found at ages 24 and 50 days. The five chicks that are known to have fledged gives a mean number of fledged young per nest of 0.05 for the 97 nesting attempts. The number of adult pairs is not known accurately, because of the extensive renesting, but the best estimate is 79, the number of active nests in the first period. Five chicks from 79 pairs gives a mean number of fledged young per adult pair of 0.06.

There are several publications concerned with the reproduction of the Herring Gull. Estimates of hatching and fledging success have been reviewed by Keith (1966) and by Kadlec and Drury (1968). These authors

TABLE 1 — Hatching success of Herring Gull eggs, related to clutch size and time of clutch initiation

	Clutch size	Number of nests	Number of eggs	Number of eggs hatched	Percent hatched of marked eggs	Mean number of eggs hatched/nest
	1	8	8	0	0	0.00
First	2	21	42	3	7	0.14
period	3	47	141	31	22	0.66
	4	3	12	1	8	0.33
Total		79	203	35	17	0.44
Second	1	4	4	0	0	0.00
period	2	4	8	1	13	0.25
	3	10	30	4	13	0.40
Total		18	42	5	12	0.28

have shown that hatching success in colonies outside the Great Lakes varies between 64% and 96%, most colonies having about 75%. The hatchability of the colony in Green Bay, Lake Michigan, was 41% (Keith 1966). The overall hatchability in this study was 16%. Fledging success in studies outside the Great Lakes generally varies between 0.5 and 1.2 fledged young per adult pair. The low fledging success in this study is comparable with that previously found in the lower Great Lakes (Gilbertson 1974). In the previous study severe contamination with organochlorine substances appeared to account for the failures.

Thus this study of the breeding success of Herring Gulls on Scotch Bonnet Island in Lake Ontario shows that failure is characterized by a high incidence of disappearance of nests and eggs and by death of embryos and chicks during incubation. Similarly, there was a high incidence of death of chicks after pipping and after hatching. The present research on this colony is directed towards finding the physiological cause of this unprecedented mortality by incubating Herring Gull eggs artificially and investigating the hatchability and condition of the chicks.

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Changes in Eggshell Quality of Belted Kingfishers Nesting in Ontario

The widely distributed Belted Kingfisher, *Megaceryle alcyon*, feeds mainly on small fish and must be regarded as a terminal consumer in an aquatic food chain, and as such would be expected to accumulate chlorinated hydrocarbon residues. Recent studies of eggshell changes in North American birds (Anderson and Hickey 1972; Faber and Hickey 1973) have avoided the smaller species because of the fragility of their eggshells. Recently, the author had the opportunity to examine a number of eggshells of this species in the collections of the National Museum of Natural Sciences and the Royal Ontario Museum, as part of a larger study of shell quality.

The eggshells were measured to the nearest 0.1 mm, weighed to the nearest 0.01 g and their thickness index calculated. Their quality was also estimated by the *beta*-backscatter technique (James and Retzer 1967; Wilson et al. 1968). Four clutches containing a total of 16 eggs collected from 1909 to 1941 constituted the pre-DDT (dichloro-diphenyl-trichloroethane) sample. Two clutches containing a total of nine eggs collected in 1951 and 1962 were used as a sample from the period when DDT was widely used. All were recorded as "fresh" when collected.

The findings are summarized in Table 1. On an individual egg basis, an F-test of the differences between means was just significant for thickness index ($P < 0.05$) and significant for *beta*-backscatter ($P < 0.01$). There is a paucity of recent material for this species. As peak contamination occurred in the mid- and late-1960s, it is likely that these changes are conservative estimates. They are comparable to those reported by Faber and Hickey (1973) for fish-eating birds in the Upper Great Lakes States.

The ROM collection contains about 50 clutches of this species, predominantly from the pre-DDT era, and it is hoped that someone will undertake a more extensive study and examine more recent material—an examination of material in private collections would seem in order. The small size of these eggs makes it necessary to

TABLE 1 — Characteristics of Belted Kingfisher eggs collected in Ontario

	Four clutches 1909–1941		Two clutches 1951, 1962		Percent change	
Beta-backscatter	31.56±1.53[a]	(n=16)	29.41±1.24	(n=9)	−6.8	$P < 0.01$
Thickness index[b]	0.795±0.024	(n=10)	0.729±0.060	(n=7)	−8.3	$P < 0.05$

[a]Mean ± standard error.

[b] $\frac{\text{Weight (mg)}}{\text{Length (mm)} \times \text{Breadth (mm)}}$ (Ratcliffe 1967).

weigh to the nearest 0.01 and preferably to the nearest 0.001 g. A comparison of recent nesting success with that attained prior to the introduction of DDT would also be appropriate.

I thank W. E. Godfrey and H. Ouellet (NMNS), and R. James (ROM) for allowing me to examine the material in their collections. The Canadian National Sportsmen's Show financed the construction of the *beta*-backscatter device which was built by F. Anderka. J. A. Keith commented on an earlier draft of this manuscript.

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Three Unusual Shortnose Sturgeons (*Acipenser brevirostrum*) from Montsweag Bay, Maine

During the summers of 1971 and 1973 in the course of other studies on the endangered (Miller 1969) shortnose sturgeon (*Acipenser brevirostrum*), three unusual specimens were captured: one with only one barbel, one with forked barbels, and one bilaterally blind.

The shortnose sturgeon normally has four single barbels in a ventral transverse row located one-third to one-half way from the tip of the snout to the upper lip. Barbel length is usually 1.50 to 2.75% of total body length.

In July 1973 we captured an individual (95 cm total length, TL) with only the rightmost barbel present. The one barbel was about two-thirds normal length, and was club-shaped instead of tapering to a point. No trace of the other three barbels was present. The specimen was released after crude total length measurement, so no precise measurements are available.

In June 1971 a sturgeon (96.5 cm TL) was captured in which three of the four barbels were forked. The barbels measured as follows (percent of TL in parentheses):

Barbel	*Length of barbel (mm)*	*Length of fork (mm)*
Right lateral	34 (3.5)	12
Right medial	25 (2.6)	5
Left medial	19 (2.0)	4
Left lateral	24 (2.5)	no fork

In July 1973 a bilaterally blind individual (113 cm TL) was captured. Both eyes were white and opaque.

The specimen was captured in a gillnet, but there was no damage in the eye region caused by the net. The sturgeon was not abnormally dark in color, and it appeared to be in good condition. Blind, dark, healthy shortnose sturgeon have also been observed by M. J. Dadswell (personal communication). Since sturgeon waters are often quite turbid, loss of vision may not be a serious impairment to normal feeding. Sturgeons are believed to rely on chemoreception more than vision in feeding, but the loss of most of the barbels may indicate that the barbels' role in gustation of shortnose sturgeon is also dispensable.

We recently reported four record-sized shortnose sturgeons (102.9 cm, 103.4 cm, 104.3 cm, and 118.1 cm TL) from Montsweag Bay (Fried and McCleave 1973). Gorham (1971), however, had already published on a 129.5-cm shortnose sturgeon, and knows of still larger ones from the Saint John River system, New Brunswick (S. W. Gorham, personal communication). Specimens considerably larger than the previously postulated maximum total length (100 cm) (Vladykov and Greeley 1963) are apparently relatively common.

We gratefully acknowledge financial support from Maine Yankee Atomic Power Company.

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Sight Record of the White-eyed Vireo in Quebec

In the early afternoon of October 31, 1971 James D. McCuaig of Ottawa, Ontario, and the author observed an immature White-eyed Vireo (*Vireo griseus*) at the foot of the Deschenes Rapids in Lucerne, Gatineau County, Quebec. The bird was briefly observed the following morning at the same locality by Ronald J. Pittaway, Roger A. Foxall, and F. Montgomery Brigham, all of Ottawa, Ontario. It was not seen after 0700 hours E.S.T. that day.

The following major field marks were observed on October 31, through 7 × 35 and 7 × 50 binoculars from approximately 30 feet away: two very distinct, yellowish-white wing bars; a very distinct yellow eye-ring which extended into "spectacles"; the forehead was crossed by a broad yellow line — the "bridge" of the spectacles; eyes were dark; lower side of head was grayish; top of head olive-brown; thick black bill; a distinct yellow patch down each side to the under-tail coverts (which were pale); the side patches joined on the breast as a yellow wash; no streaking on the bird; throat dingy, separated from the yellowish breast by a gray band; had the deliberate, steady movements typical of Vireos.

The bird consistently perched 8 to 10 feet off the ground in a small group of apple trees, and was quite tame. The large number of midge-like insects swarming over the top of these trees was apparently the main attraction for the bird, and it was seen to snatch these up on several occasions. More detailed field notes have been given to Mr. H. Ouellet of the National Museum of Natural Sciences.

A strong, southwesterly wind had been active from October 13, bringing unseasonably warm weather into the Ottawa Valley. This wind pattern (being particularly pronounced on October 27) may have been responsible for the bird's presence.

This constitutes the first report of the White-eyed Vireo for the province of Quebec, as well as the fourth record for the Ottawa-Hull District.

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Some Bryophytes of Silumiut Island, Northwest Territories[1]

During the summer of 1969 the senior author studied vascular plant communities on Silumiut (63°41′ N, 90°05′ W), a small island about a mile in diameter on the northwest coast of Hudson Bay, and briefly at Chesterfield (63°20′ N, 90°40′ W) some 28 miles to the southwest of that island. Although the primary purpose of the field work was to compare vascular vegetation on Thule-age habitation sites (ca. A.D. 1200) with vegetation on undisturbed but otherwise complementary sites (McCartney, N. G. Ecology of Silumiut with special reference to the influence of Thule Eskimos. Manuscript), some non-vascular plants were collected. Three liverworts and 47 mosses are reported in this paper. Previous investigations of note include those of Steere (1947) for the west coast of Hudson Bay and Southampton Island; Persson and Holmen (1961) for Southampton Island; Scotter (1966) for the Thelon River area; and Brassard (1973) for Southampton Island. The state of arctic bryology in general is summarized by Schofield (1972), and in detail by Brassard (1971a, b) for the ecology and phytogeography of Ellesmere Island.

One must heed Steere's (1947) admonition and omit ". . . notes on the abundance, local distribution and association of the species, because only authentic notes on these topics made by critical collectors who are familiar with byophytes in the field can be used for this purpose." But it is of interest to mention those mosses which occurred in human or animal habitation sites at Silumiut and Chesterfield for future comparisons. In all, 26 Silumiut mosses grew on house pits and 12 on animal burrows. Most of these mosses were collected on undisturbed sites also, but several were collected exclusively from house pits (*Sphagnum fuscum, S. girgensohnii, Ditrichum flexicaule, Thuidium abietinum, Polytrichum commune, P. strictum*) or exclusively from animal burrows (*Leptobryum pyriforme, Pohlia proligera, Bryum arcticum, B. argenteum*) or from one house pit and one animal burrow (*Plagiothecium cavifolium*). Neither of the Splachnaceae in the collection, *Tetraplodon mnioides* or *Haplodon wormskjoldii*, were found exclusively on the house pits, which would be expected to show the highest nutrient content of any location on the island. Brassard (1971b) listed several mosses which occurred around human habitations in Ellesmere Island, but cautioned (Brassard 1971a), "At Fort Conger . . . some more or less anthropophilous mosses have become extremely well established, especially in the immediate vicinity of the campsite. Other mosses appear to be in some way closely associated with Palaeo-Eskimo ruins or with recent human activity but none is restricted to such places."

The vascular plant communities (McCartney, manuscript [see above]) from which the collections were made are summarized as follows. (These are arranged in their approximate areal importance in descending order; all are from Silumiut except where noted.)

- MB — Moss-lichen barren. Open community on exposed granite-gneiss bedrock. *Poa arctica* R. Br. ssp. *arctica* and *Hierochloe alpina* (Sw.) R.&S. are conspicuous members of the vascular flora. Many crustose lichens present.
- SF — Saxifrage fellfield. Open community with *Saxifraga tricuspidata* Rottb. and *Elymus arenarius* L. ssp. *mollis* (Trin.) Hult. as the most conspicuous vascular plants. Substrate ranging from shattered rock or cobbles to sand.
- LH — Lichen heath. Closed community with *Vaccinium vitis-idaea* L. var. *minus* Lodd., *Vaccinium uliginosum* L., *Salix arctica* Pall., and other small shrubs embedded in a matrix of lichens. Typical of well-drained, sandy hillsides.
- CB — Cloudberry bog. *Rubus chamaemorus* L., *Empetrum nigrum* L., and carices in a matrix of mosses.
- WT — Willow tussock. *Salix arctica* Pall., *Salix reticulata* L., and carices on tussocks near pond margins.
- MD — Mossy draw. *Salix arctica* Pall. and *Salix herbacea* L. in north-facing draws, with subsurface drainage through mosses from central hill to lake-filled area below. Solifluction lobes present.
- CM — Cottongrass marsh. Marsh with *Eriophorum* sp., *Dupontia fisheri* R.Br., and carices in water-saturated mosses.
- PM — Poa meadow. Closed community of *Poa arctica* R.Br. ssp. *arctica, Poa alpigena* (Fr.) Lindm., *Cardamine pratensis* L. var. *palustris* Wimm. & Grab., *Callitriche anceps* Fern. in moist mosses.
- HPS — House pit at Silumiut. Collapsed remains of Thule Eskimo winter houses dating from ca. A.D. 1200.
- HPC — House pit at Chesterfield of presumably the same date as HPS.
- AB — Animal burrow. Directly around the entrance of lemming or ground squirrel burrows.
- DD — Drainage ditch between high centered polygons. Cotton grasses and mosses present.

Voucher specimens marked (*) are deposited in the University of Michigan Herbarium; the rest are in the personal collection of N.G.M. Numbers in the following list refer to the number of communities of each kind in which the mosses were found. Nomenclature follows Crum et al. (1973), except for *Mnium affine* Bland *ex* Funck.

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HEPATICAE

*Blepharostoma trichophyllum (L.) Dum.—2 CB; MD; 2 HPS.
*Ptilidium ciliare (L.) Hampe—SF; MB.
*Sphenolobus minutus (Crantz) Stephani—3 LH; 3 CB; 3 MD; WT; MB; 5 HPS.

MUSCI

*Aulacomnium palustre (Hedw.) Schwaegr.—2 SF; 3 CB; 2 MD; 2 WT; 3 MB; HPC; 8 HPS.
*Aulacomnium turgidum (Wahlenb.) Schwaegr.—SF; 2 CB; 3 MD; WT; 4 MB; 2 HPS.
Bryum arcticum (R.Br.) B.S.G.—AB.
Bryum argenteum Hedw.—AB.
*Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb.—MD; 2 HPS; DD; PM.
Calliergon cordifolium (Hedw.) Kindb.—PM.
*Calliergon sarmentosum (Wahlenb.) Kindb.—CM.
*Calliergon stramineum (Brid.) Kindb.—CB; MD; WT; CM; 2 HPS; HPC; DD; PM.
*Ceratodon purpureus (Hedw). Brid.—2 SF; 2 MB; HPC; 4 AB; 4 HPS.
*Cinclidium subrotundum Lindb.—CM.
*Cynodontium strumiferum (Hedw.) Lindb.—LH; 2 MB.
*Dicranum angustum Lindb.—2 CB; 2 MB; 2 HPS.
*Dicranum elongatum Schleich. ex Schwaegr.—5 LH; 4 CB; 2 MD; 6 MB; AB; 6 HPS; DD.
Dicranum fuscescens Turn.—MB; AB; HPS.
Dicranum montanum Hedw.—MB.
Dicranum muehlenbeckii B.S.G. var. *cirratum* (Schimp.) Lindb.—SF.
Ditrichum flexicaule (Schwaegr.) Hampe— 2 HPS.
*Drepanocladus aduncus (Hedw.) Warnst.—HPS; DD.
Drepanocladus fluitans (Hedw.) Warnst.—MD.
*Drepanocladus uncinatus (Hedw.) Warnst.—2 MB.
*Haplodon wormskjoldii (Hornem.) R.Br.—CB; HPS.
*Hylocomnium splendens (Hedw.) B.S.G.—WT.
*Hypnum hamulosum B.S.G.—3 CB; MB.
*Leptobryum pyriforme (Hedw.) Wils.—6 AB.
*Mnium andrewsianum Steere—WT.
*Mnium affine Bland ex Funck—MD; WT; HPC; 6 HPS; AB; DD; PM.
*Onchophorus wahlenbergii Brid.—MD; MB.
*Orthotrichum speciosum Nees. ex Sturm—SF; also found on a seal scapula.
Philonotis fontana (Hedw.) Brid.—PM.
*Plagiothecium cavifolium (Brid.) Iwats.—AB; HPS.
Plagiothecium denticulatum (Hedw.) B.S.G.—MB; 2 HPS.
*Pogonatum alpinum (Hedw.) Roehl.—2 HPS.
Pohlia cruda (Hedw.) Lindb.—MD; 2 AB; HPS.
*Pohlia nutans (Hedw.) Lindb.—3 MB; 5 AB; 3 HPS; DD.
*Pohlia proligera (Kindb. ex Limpr.) Lindb. ex Arnell—3 AB.
Polytrichum commune Hedw.—HPS.
*Polytrichum juniperinum Hedw.—LH; SF; CB; 2 MD; 2 MB; AB; 4 HPS; DD.
Polytrichum strictum Brid.—WT; 5 HPS.
*Pterigynandrum filiforme Hedw.—SF.
*Rhacomitrium lanuginosum (Hedw.) Brid.—3 SF; 2 MB.
Rhytidium rugosum (Hedw.) Kindb.—AB; HPS.
*Sphagnum fimbriatum Wils. ex J. Hook.—2 CB; WT; HPS.
Sphagnum fuscum (Schimp.) Klinggr.—HPS.
*Sphagnum girgensohnii Russ.—CB; CM; HPS.
*Tetraplodon mnioides (Hedw.) B.S.G.—CB; HPS; DD.
*Thuidium abietinum (Hedw.) B.S.G.—HPS.
*Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb.—SF; also on a seal scapula.

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Small Mammals and Amphibians Captured in a Mature Stand of Red Spruce[1]

Abstract. Eight species of small mammals and nine of amphibians were captured in pitfall traps used to study the numbers and distribution of soil fauna within a mature stand of red spruce (*Picea rubens* Sarg.). *Sorex cinereus acadicus* Gilpin and *Clethrionomys gapperi ochraceus* (Miller) were the most frequently captured small mammals. *Rana sylvatica* Lec. was the most common amphibian.

This investigation is part of a larger study of the soil fauna in a mature stand of red spruce (*Picea rubens* Sarg.) in the University of New Brunswick Forest. The site is located on the east of Highway 28 about 1 mile south of the university campus. Because of the lack of qualitative and quantitative data on small mammals and amphibians in this ecosystem, this paper reports the species present in this habitat and their relative abundance as reflected by pitfall trapping from May to November during the 4 years 1968 to 1971.

The stand was even-aged red spruce, about 90 years old, single-storied, and approximately 70 feet high. Schreber's moss (*Pleurozium schreberi* (B.S.G.) Mitt.) was the dominant ground cover and the soil was a Sunbury gravelly sand loam having a litter/humus layer about 2 inches thick with a moisture regime of 2.5 and pH of 4.2.

Materials and Methods

Each pitfall assemblage consisted of a plastic funnel[2] 8 inches in top diameter and 1.5 inches in bottom diameter. A Mason jar containing 100 ml of 70% ethanol was fixed to the funnel and placed in a metal sleeve set 1.5 feet in the ground so that the funnel was level with the ground surface. A 1-foot-square aluminum shield on 6-inch-high pegs was placed over each trap to reduce the amount of debris and water falling into it.

There were 12 pitfall traps tended weekly from May to November in each of the 4 years 1968 to 1971. Specimens were stored in 70% ethanol until identified. The nomenclature for mammals was that of Peterson (1966) with the subspecies being related to distribution. The nomenclature of Gorham (1970) was used for amphibians.

Results and Discussion

Mammals

Three species of insectivores and five of rodents were captured during the study (Table 1). *Sorex cinereus acadicus* Gilpin and *Clethrionomys gapperi ochraceus* (Miller) were the two species of small mammals most frequently captured. Table 2 shows these mammals to be

TABLE 1 — Summary of small mammal captures, 1968–1971

Mammals captured	1968	1969	1970	1971	Totals all years
Insectivora					
Sorex cinereus acadicus Gilpin	18	61	62	88	229
Microsorex hoyi thompsoni (Baird)	2	10	7	7	26
Blarina brevicauda pallida Smith	8	14	2	6	30
Total insectivore captures	28	85	71	101	285
Rodentia					
Peromyscus maniculatus abietorum Bangs	0	1	1	4	6
Synaptomys cooperi cooperi Baird	0	5	0	2	7
Clethrionomys gapperi ochraceus (Miller)	14	29	25	28	96
Zapus hudsonius acadicus (Dawson)	0	0	1	2	3
Napaeozapus insignis insignis (Miller)	2	4	2	2	10
Total rodent captures	16	39	29	38	122
Total small mammal captures	44	124	100	139	407

[1]Contribution Number 12 of the Faculty of Forestry, University of New Brunswick was supported by a grant from the National Research Council of Canada. This paper is based on part of an M.Sc.F. thesis submitted by N. E. Carter to the University of New Brunswick.

[2]Funnel No. 3009, George Cluthe Manufacturing Co., 141 Weber St., S., Waterloo, Ontario, Canada.

TABLE 2 — Total monthly captures of *S. c. acadicus* and *C. g. ochraceus*

		Number captured							
Species	Year	May	June	July	Aug.	Sept.	Oct.	Nov.	Totals
S. c. acadicus	1968	1	0	0	4	4	5	4	18
	1969	1	5	5	13	6	21	10	61
	1970	0	2	19	25	8	8	0	62
	1971	0	3	15	29	21	14	6	88
C.g. ochraceus	1968	0	0	0	0	1	5	8	14
	1969	0	0	10	4	4	8	3	29
	1970	0	1	7	6	2	8	1	25
	1971	0	1	11	3	4	4	5	28

TABLE 3 — Summary of amphibian captures, 1968–1971

Amphibians captured	1968	1969	1970	1971	Totals all years
Caudata					
Ambystoma maculatum (Shaw)	3	5	1	4	13
Ambystoma laterale Hallowell	0	0	1	2	3
Plethodon cinereus cinereus (Green)	8	13	18	7	46
Total salamander captures	11	18	20	13	62
Salientia					
Bufo americanus americanus Holb.	0	1	0	0	1
Hyla crucifer crucifer Wood	2	5	5	3	15
Hyla versicolor versicolor Lec.	0	0	0	3	3
Rana sylvatica Lec.	2	11	25	12	50
Rana pipiens pipiens Sch.	0	0	0	5	5
Rana palustris Lec.	9	10	3	1	23
Total frog and toad captures	13	27	33	24	97
Total amphibian captures	24	45	53	37	159

most abundant during the mid-summer (July) to fall (October) period. This agrees with the observation made by Morris (1943) and is a reflection of the breeding season which extends from early spring to fall for both mammals (Peterson 1966).

Amphibians

Table 3 lists the three species of salamanders, five of frogs, and one toad captured in this study. These represent 9 of the 15 recorded native New Brunswick species of amphibians (Gorham 1970). *Plethedon cinereus cinereus* (Green) was the salamander most commonly captured; this is a reflection of its adaption to this habitat. Likewise, *Rana sylvatica* Lec. was the most frequently captured frog.

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Breeding Records of the Gadwall on Prince Edward Island

Two broods of Gadwall (*Anas strepera*) were recorded on Prince Edward Island in 1973, the first breeding record for this species in the Maritime Provinces. Gadwall have been reported on Prince Edward Island by MacSwain (1908) and Hurst (1947) but no specimens were preserved, and Godfrey (1954) considered the occurrence of Gadwall on Prince Edward Island to be hypothetical. In wing collection surveys conducted in the Atlantic Provinces by the Canadian Wildlife Service since 1967, Gadwall wings have not occurred.

In the spring of 1967, Walter Stewart, Conservation Officer with the Prince Edward Island Fish and Wildlife Division, reported a lone Gadwall drake in the Cardigan River impoundment. The male frequented the area for several weeks but no female or brood was observed.

Guignion observed a pair of Gadwall at Indian River in 1970 and a pair plus a lone drake were seen the following spring, but no broods were recorded. Although breeding pairs were not seen in 1972, a brood that was identified as a "possible" Gadwall was spotted while a helicopter survey was conducted at Indian River in July of that year. In 1973 a breeding pair plus a waiting drake were seen in the Indian River marsh. Six newly-hatched ducklings were observed on July 7 and another brood of 10 on July 9. On both occasions the females and broods were pursued by canoe, positively identified, and photographed. Thirteen local Gadwall, comprising two age classes, were caught and banded during August.

A 44-acre (17.8-ha) impoundment at Indian River was created in 1966 on a former salt marsh adjacent to agricultural land. It is currently a provincial wildlife management area where hunting is prohibited. Since the water control structure allows only an occasional influx of salt water during storm tides the area is essentially a freshwater marsh. Typical of artificial impoundments on Prince Edward Island the water is alkaline (pH 8.4; 74 ppm Ca CO_3), which results in lush growths of aquatic vegetation (Figure 1). Approximately three-fourths of the area is

FIGURE 1. Freshwater marsh at Indian River.

flooded with less than 2 feet of water. The dominant submerged vegetation consists of dense beds of pondweeds (*Potamogeton berchtoldi* and *P. pectinatus*). Bulrush (*Scirpus acutus*), cattail (*Typha latifolia*), arrowhead (*Sagittaria latifolia*), and sweet gale (*Myrica gale*) are the predominant emergents. Duckweed (*Lemna minor*) is common throughout, often occurring in dense mats. Dominant shoreline vegetation includes broad-leaf (*Spartina pectinata*), blue-joint (*Calamagrostis canadensis*), sedges (*Carex* spp.), and rushes (*Juncus* spp).

In addition to Gadwall, the following broods of other waterfowl were observed during 1973 at Indian River: five Blue-winged Teal (*Anas discors*), three Black Duck (*A. rubripes*), one Pintail (*A. acuta*), one Green-winged Teal (*A. carolinensis*), one Mallard (*A. platyrhynchos*), two American Wigeon (*Mareca americana*), two Northern Shoveler (*Spatula clypeata*), and two Ring-necked Duck (*Aythya collaris*).

Henny and Holgersen (in press) have documented the extension of Gadwall breeding range along the Atlantic coast during the past 30 years and have records of its breeding from South Carolina to Massachusetts, mainly in freshwater impoundments. Other waterfowl have recently extended their breeding range into the Maritime Provinces (Bartlett 1960) and the occurrence of Gadwall breeding on Prince Edward Island is consistent with these recent changes.

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Sighting of a Yellow Wagtail on Old Crow River, Yukon Territory

While collecting Pleistocene vertebrate fossils along the Old Crow River between Timber and Black Fox Creeks on 6 August 1973, I had occasion to tie the boat to willows below a sheltered bluff on "Black Bear Bend" (68°06′42″ N, 139°55′00″ W). The wind was southwest at approximately 12 mph and the sky was covered by about 5/10 cumulus and 3/10 altocumulus cloud. After about 20 minutes (12:30 p.m. Northern Yukon Time) I noticed a small bird flying overhead. It appeared to be slightly larger than a House Sparrow (*Passer domesticus*) and was a very manoeuverable flyer. It hovered over the river and dipped quickly in and out of the water surface before landing on the sandy point bar opposite the boat. I was able to view the bird through binoculars for about 20 minutes before I departed from the area. Its most remarkable feature was a long, blackish tail, which it began twitching as soon as it landed and started to walk around. The species was new to me, although I had kept records on birds in the area for the previous 6 years. The size of the bird, its twitching tail, dark head, and bright yellow underparts led me to conclude it was an adult Yellow Wagtail (*Motacilla flava*); and I was able to check this identification at the time in *Birds of North America* (Robbins et al. 1966). The species was not detected previously by Irving (1960) in the Old Crow region.

The Yellow Wagtail ranges throughout Eurasia, western and northern Alaska, and northern Yukon Territory. Smith (1950, p. 2) states that the Alaskan Yellow Wagtail (*Motacilla flava alascensis*) originally bred only in extreme northeastern Siberia but has extended its breeding range to Alaska. Apparently its breeding range is spreading farther eastward for it is found in summer near the mouth of Firth River where it probably breeds (Godfrey 1966, p. 307), a position approximately 100 miles north of the Old Crow River observation point. In June 1972 Black (1973, p. 385) sighted 6 pairs of Yellow Wagtails

and found a nest with five eggs on Babbage River about 75 miles north-northeast of the Old Crow locality.

This observation on Old Crow River evidently represents the southernmost occurrence record for the species in Canada. Because the date of observation is after the nesting season, probably this individual was a wanderer from its nesting grounds.

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Apparent Hybridization between a Common Loon and an Arctic Loon

Apparently hybridization in loons can occur, in spite of normal plumage and calls. On July 16, 1973 we located a family of loons composed of an adult Common Loon (*Gavia immer*) and an adult Arctic Loon (*Gavia arctica*) plus two chicks about 5 days old (Figure 1). They were on a small lake at approximately 69°00′ N, 133°31′ W, several miles north of the tree-line. Both adults were in typical nuptial plumage and on several occasions each gave calls appropriate to its species. This family was observed again on July 18, and regularly between August 14 and 22. By August 14 there was only one chick surviving. When we made our last observations (August 22) this chick appeared healthy, and probably survived the 7 to 10 days necessary to fledge.

During the 8 days in which these loons were seen, we observed them for about 5 hours. The behavior of the mixed pair differed in no obvious way from nearby families of Common Loons and Arctic Loons. Early in brood-rearing it was the Common Loon which behaved 'aggressively' towards us, calling and following us around the lake, while the Arctic Loon remained with the chicks in a less conspicuous place. By August, when brood attentiveness had declined, the Common Loon tended to stay with the chick; other loon broods observed at this time were frequently escorted by a single parent.

As we did not locate these loons until after hatching, there is always the chance that one of the original pair which produced the brood disappeared and that a replacement paired with the remaining parent. But this seems unlikely since it is difficult to imagine pair formation taking place during successful incubation or in the brief period between hatching and the time we found the brood.

Figure 1. Common Loon × Arctic Loon brood. Common Loon on left.

Palmer (1962. Handbook of North American Birds. Volume 1. Yale University Press, New Haven. 567 pp.) cites a possible case of Common Loon × Arctic Loon hybridization from Belgium.

We made these observations while conducting environmental studies for the Gulf, Imperial, and Shell Oil Companies.

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First Ontario Specimen of the Yellow-throated Warbler

In May 1970, two Yellow-throated Warblers (*Dendroica dominica*) were captured at Long Point Bird Observatory (LPBO), Long Point, Norfolk County, Ontario. The first was captured on 12 May at about 12:30 p.m., sexed by plumage as a male, banded and released. Many migrating birds were attracted to the Long Point Lighthouse on the night of 24–25 May when the tip of Long Point was covered with heavy fog. Michael Alexander, then LPBO warden, and I spent the night at the top of the lighthouse, where we estimated that at least 20,000 passerine birds were attracted to the light during the night. At dawn, as the sky lightened, the swarm of birds which had been present at the light all night quickly thinned and disappeared. One of the last birds to land on the lighthouse that morning was a Yellow-throated Warbler, which I collected (JGS 51). The specimen, a female of the race *albilora*, is now in the collections of The University of Michigan Museum of Zoology (No. 216,627) and represents the second specimen of the species for Canada* and the first for the Province of Ontario. The first Canadian specimen was collected at St. John's, Newfoundland, on 11 November 1953 (Godfrey, W. E. 1966. The birds of Canada. National Museum of Canada Bulletin 203. 428 pp.).

I find six sight records for this species in the Ontario – Western New York region section of *Audubon Field Notes* and *American Birds* from 1968 to 1972. It appears that the Yellow-throated Warbler may now be a regular but rare bird in Ontario.

I thank the Long Point Bird Observatory for use of its facilities. Field studies during which this observation was made were supported by a grant from the National Science Foundation (GB-8212) to Nelson G. Hairston, The University of Michigan, for research in systematics and evolutionary biology.

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*There are additional records supported by photographs for Nova Scotia and Quebec—Associate Editor (Ornithology).

Ivory Gulls, *Pagophila eburnea*, on the water[1]

The Ivory Gull, *Pagophila eburnea*, is one of the most northerly-ranging species of seabird in the high arctic. It is most often seen close to sea ice, although it also frequents open water areas in summer (Godfrey 1966). Unlike other arctic gulls it is seldom seen on the water. N. Tinbergen (appendix to Bateson and Plowright 1959, p. 172) comments on the Ivory Gull's "peculiar reluctance to swim (a reluctance which may, however, be learnt by each individual after a bathe in freezing Arctic water)." Similarly, Salomonsen (1972, p. 55) states that Ivory Gulls "never alight on the water" and suggests that this is an adaptation against the danger that water on the birds' feathers may freeze into an ice crust. Madsen and Wingstrand (1959) make the same point about seabirds and ducks in general. They also note the danger of frostbite to the feet and legs. This is a particular risk, not so much when the birds are swimming, however, as when they fly up and expose their feet to a much lower air temperature.

We have several records of Ivory Gulls sitting on near-freezing water in northern Baffin Bay (Table 1). In most cases our ships were in or very close to sea ice, which would have provided the birds with an alternative resting place. In two cases small flocks sat on the water for over an hour beside the stationary ship, apparently waiting for garbage to be thrown overboard. In view of Madsen and Wingstrand's (1959) observations, it seems significant that the temperature of the air was very similar to that of the water, and that since wind speeds were usually low, the wind-chill factor must have been slight. Presumably there was little risk of frostbite or feather-freezing under such conditions.

Ivory Gulls were also seen landing briefly on the water while feeding on whale offal at sea (S. D. MacDonald,

[1]An investigation associated with the program "Studies on northern seabirds," Canadian Wildlife Service, Environment Canada (Report Number 22).

personal communication) and in shallow water (Nettleship, personal observations) in the vicinity of Cornwallis Island in August 1969 and August 1972, respectively. On 1 August 1972 a small flock of about 18 Ivory Gulls was apparently on the water feeding when first sighted near Dundas Harbour, Devon Island, in Lancaster Sound (Nettleship 1974).

Evidently the Ivory Gull is not as reluctant to alight on water and swim as previous accounts suggest.

We thank the captains, scientific personnel, and crew of *CSS Hudson* and *CSS Dawson* for their help and cooperation during our oceanographic surveys.

TABLE 1 — Observations of Ivory Gulls sitting on the water

Date	Position	Number of birds	Temperatures (°C)		Wind (knots)	Sea ice	Remarks
			Air	Sea			
11 September 1970	73°30′ N, 64°30′ W	13	0.2	−0.9	5	Nearby	Sat on water for over an hour
10 September 1971	74°10′ N, 66°46′ W	ca. 14	−2.2	−0.5	13	Distant	
24 September 1971	76°19′ N, 82°35′ W	2	−2.6	−1.6	0	Nearby	
	75°53′ N, 82°15′ W	2	−1.4	−0.5	28	Nearby	
27 September 1971	74°06′ N, 71°28′ W	4	−0.4	0.0	14	Nearby	
29 September 1971	73°52′ N, 64°14′ W	4	−1.5	−0.8	6	Nearby	Landed briefly while feeding
30 September 1971	72°15′ N, 63°47′ W	ca. 8	−1.1	−0.4	10	Absent	Sat on water for at least 1½ hours
2 October 1971	70°14′ N, 63°28′ W	2	0.6	0.2	10	Absent	Landed briefly while feeding

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The Gray Jay as a Predator of Small Mammals[1]

The Gray Jay (*Perisoreus canadensis*) is one of the most characteristic birds of the northern coniferous forest, yet many aspects of its life history are poorly known. Although many observers have described the diverse food habits of this bird (Taverner 1926, 1934; Bent 1946; Harper 1953; Salt and Wilk 1966; Stirling 1968; Henshaw 1970; Ouellet 1970; Rutter 1972), a survey of the literature reveals few reports of the Gray Jay's role as a predator. As stated by Ouellet (1970), most observations of Gray Jay predation indicate that this activity is directed primarily against nests containing eggs or young, or against young birds still depending to a large extent on their parents for survival. No actual observations have been published of the Gray Jay's preying upon small mammals. The purpose of this report is to show that the Gray Jay can successfully prey upon small mammals, and to suggest that it may be a more important predator than previously supposed.

Predation on Deermice

On 25 October 1973, while engaged in field reconnaissance work on the subalpine forest zone near the headwaters of the Wildhay River in the Willmore Wilderness area of western Alberta (adjacent to the north side of Jasper National Park), I witnessed one or more Gray Jays successfully preying upon two boreal deermice (*Peromyscus maniculatus borealis*).

The day before this observation was made had been clear and warm, and the upper surface of the 30-cm snow cover had thawed. Reduced temperatures later in the day caused a hard, dense sun crust some 2 cm thick to form on the surface. While walking across a sedge (*Carex* spp. and *Eriophorum* spp.) meadow that evening, I left discrete holes through this crust.

The next morning, while retracing these steps, I saw several deermice running about on top of the crusted snow on the sedge meadow. They had apparently emerged through the holes in the crust made by my tracks. My attention was next drawn to a Gray Jay which flew out from an adjacent lodgepole pine (*Pinus contorta* var. *latifolia*) stand and alighted excitedly near one of the mice. After a short and ineffectual bid to escape, the mouse stood on its hind legs in an attempt to fend off the jay which had begun to peck at its head. After pecking at the mouse more or less successfully for approximately 1 minute, the jay flew away with the mouse, even though the mouse was still struggling feebly. Although adult deermice in Alberta range in weight from 18 to 34 grams (Soper 1964), the jay did not appear to experience any particular difficulty in carrying it off. In transporting this mouse, the jay used its bill only. It did not transfer the load in flight from its bill to its feet, as is reported by Stirling (1968) to be common in Gray Jays.

Shortly after this incident, what may have been the same jay flew to the site from the direction in which the first had flown, and successfully preyed in a similar manner on another deermouse. This mouse was either unconscious or dead, as it hung limp and unmoving when the jay flew off with it. I waited for some 30 minutes but did not witness another attempt at predation, although other deermice were seen occasionally on top of the crusted snow. I then tried to determine whether the mice were actually eaten by the jay, but could not locate either prey or predator.

This predatory activity coincided with the first major snowfall of the winter, and at a time when the young-of-the-year jays were still dispersing (Boag, personal communication, 1973). If the observed jay was a young individual which was entering new territory, the resultant loss of its traditional food base would be accentuated by the first snow cover, and these circumstances together with the opportunity afforded by the exposed mice could have stimulated the predatory behavior. A comparable case of predation on mice (*Zapus princeps*) by a Robin (*Turdus migratorius*) is reported by Jonkel (1966). He similarly attributes it to a post-breeding movement by Robins into marginal habitat, where with fewer typical foods, there was a shift to predation.

Predation on other Small Mammals

Although the Gray Jay is not morphologically well equipped to be a predator of small mammals, it nevertheless appears to be sufficiently aggressive and strong to enable it to function as one. Bendire (1895, p. 387), for example, claimed that the Gray Jay "is equally rapacious and destructive as the Blue Jay." Bent (1946) reports that a pair of Gray Jays attacked a weasel (*Mustela erminea*) that had disturbed their nest, and they eventually drove it off, drawing considerable blood in the process. In another account (Henshaw 1970), Gray Jays were observed to peck at a red squirrel (*Tamiascurus hudsonicus*) during an apparent territorial conflict. In Quebec, Ouellet (1970) observed a Gray Jay carrying in its bill a small mammal that was later identified as a boreal red-backed vole (*Clethrionomys gapperi*), which had been killed by sharp blows to the skull, presumably by the jay.

If these observations are not atypical, then it is not unreasonable to expect that the relative sturdiness and opportunistic feeding habits of the Gray Jay may combine to enable it to function not only as a predator of eggs and young birds, but also as a predator of small mammals when the right combination of circumstances occurs.

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My oservations, together with Ouellet's (1970) report from Quebec, suggest that the Gray Jay may be a more important predator in the boreal forest than previously known ("the role of which is still mostly undetermined" (Ouellet 1970, p. 327)). It is therefore hoped that this and Ouellet's paper will stimulate a wider reportage by naturalists of observations on the predatory activities of the ubiquitous, but still poorly known, Gray Jay.

These observations were made while I was doing field work supported by NRCC Grant A8700. Appreciation is extended to W. Earl Godfrey and Charles Jonkel, who made valuable criticisms of the manuscript.

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News and Comment

Centennial Planning Group — The Ottawa Field-Naturalists' Club

The following resolution was moved by Hue MacKenzie at the Council Meeting held April 15, 1974. The resolution was passed and the initial appointees are Ernie Brodo, Chuck Gruchy, and Hue MacKenzie. Members should start thinking now about the way in which they want to see our 100th anniversary commemorated. The planning group wants ideas and is looking to you, the members, for help in planning this very important event in our Club's life. If you have something to offer, contact one of the people named above.

Motion

Moved that a Centennial Planning Group be appointed to commence consideration of how the Club should celebrate its one-hundredth anniversary in 1979.

Discussion

As the oldest natural history club in Canada, we have a right and a responsibility to make the event one of the highlights in Canada in 1979. It represents a great opportunity to make the public at large aware that a love of nature and a concern for its conservation is not just a recent development. Our plans should ensure a thorough mix, including acknowledging our origins, describing our accomplishments, and publicizing our objectives so that those who share our outlook can join in helping us.

To do these things successfully, we need to have a plan based on identifying the possible and rejecting the impossible or impractical. This necessitates creating a planning group to obtain and evaluate suggestions and place proposals before the Council. The group should consist of people who can evaluate proposals and not be carried away by enthusiasm for schemes which would be beyond our very considerable capabilities. It should include optimists and the theme should basically be, how can we make it happen? Not, can we afford it? At the same time, they must be realists capable of determining when an idea is simply too costly or too grandiose. In this way, we will stretch our talents and resources to the limit but *not* beyond it.

April 30, 1974

Nouveau programme federal-provincial au Manitoba en vue d'accroître la reproduction faunique au marais Delta

L'une des Réserves de la faune les plus fameuse d'Amérique du Nord, le marais Delta, situé à l'extrémité sud du lac Manitoba, sera l'objet d'un important programme d'aménagement. La réhabilitation du marais se fera conformément aux dispositions d'un plan approuvé par les administrations provinciale et fédérale.

Ces dernières années, l'état général du marais Delta s'est détérioré à tel point que la reproduction faunique actuelle est fort inférieure à son potentiel. Le rajeunissement consistera en un certain nombre de mesures de gestion destinées à faire augmenter la reproduction faunique, particulièrement chez les oiseaux aquatiques et les animaux à fourrure.

Le plan prévoit la construction de compartiments, de voies d'accès et autres installations, y compris des structures de retenue des eaux. La régularisation de la végétation naturelle et des niveaux d'eau seront les principales méthodes de revitalisation du marais.

Le projet prévoit, à l'intérieur du marais, l'acquisition des terrains nécessaires à la régularisation des niveaux d'eau. Il y aura aussi des programmes d'interprétation dans le marais pour renseigner, éduquer le public.

Communiqué, Ottawa le 18 mars, 1974.

"The World We Live In"

The 3rd International Congress of the World Wildlife Fund meeting in Bonn, Germany, on 5 October 1973 was devoted to the theme: **The World We Live In.**

The Congress identified the human population explosion as the prime cause of the environmental crisis, and affirmed the conviction that all governments should consider world policies directed towards the stabilisation and ultimately the reduction of populations according to the carrying capacity of the land and oceans. Such measures are of the highest priority not only in the interests of conservation of natural resources but also for achieving the highest quality of life for all mankind.

The Congress was particularly concerned at the sharp rises in consumption of natural resources of all kinds and drew attention to the looming crisis for energy and materials that will plague all nations before the end of the century.

It appealed to decision makers and their consultants, to the producers and the consumers, to give heed to the limited resources of planet Earth and so to order their activities in accordance with the dictates of human conscience and responsibility as to avoid gross waste of resources and neglect of ecological principles.

Reprinted from Supplement to IUCN Bulletin 4(11), November 1973.

Forest History Society Bibliographic Project

The Forest History Society (P.O. Box 1581, Santa Cruz, California 95061) has appointed Richard C. Davis and Ronald J. Fahl to prepare two reference works for students of North American forest and conservation history, to be published in 1976. The National Endowment for the Humanities has provided major funding for the project.

Davis's guide will describe the manuscript collections and other unpublished materials which constitute sources of forest and conservation history. Having identified and located many collections through preliminary research in published guides, Davis has nearly completed mail inquiries to more than 300 repositories. He is now engaged in follow-up correspondence and plans a limited number of personal visits to archival institutions with particularly large holdings.

Fahl's annotated bibliography will identify the published literature and doctoral dissertations bearing on the history of man's exploitation, conservation, and appreciation of North American forests and forest resources. He is emphasizing works consciously written as history, as distinct from published source materials.

Although the finished works will be indexed and published as separate volumes, they are intended to be complementary research tools for historians and other scholars in this growing field. Further details on the scope and organization of either project can be obtained by writing Davis or Fahl at the above address.

Protection for polar bears

An Agreement on Conservation of Polar Bears was concluded at Oslo on 15 November 1973. Five Arctic States, Canada, Denmark, Norway, USSR, and USA, participated in a three-day Conference which ended with the signing of the Agreement by four nations; USSR is also expected to sign soon.

The new accord will give almost complete protection of polar bears in the Arctic. Taking of polar bears is banned although some defined exceptions are allowed, most importantly traditional hunting by local people.

The Agreement calls for each country to carry out research on polar bears and to coordinate research and exchange information with other parties.

This is the first treaty between the five Arctic States. Hopes were expressed that it would lead to further accord among the countries in matters relating to conservation in the Arctic.

Reprinted from IUCN Bulletin 4(12), December 1973.

Notice

To Individual and Family Members Not Resident in the Ottawa Area

Trail & Landscape is a non-technical publication of The Ottawa Field-Naturalists' Club. It includes articles on Ottawa-area natural history as well as Club news items. It will be sent to you at no cost if you request it in a letter to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada K1Y 4J5. *Librarians should note* **that this does not apply to institutional subscribers.**

Book Reviews

Zoology

The Spring Birds of Point Pelee National Park, The Summer Birds of Point Pelee National Park, The Autumn Birds of Point Pelee National Park, The Winter Birds of Point Pelee National Park

By George M. Stirrett. 1973. Parks Canada. Indian and Northern Affairs Publications, Number QS-(1052, 2089, 2091, 2090)-000-EE-A1. 120 pp. (total). Information Canada, Ottawa. Each $.50 (Paper).

The four booklets of this series are seasonal summaries of the birds of Point Peleee National Park in Ontario. Each contains a list of the birds recorded in that season, with data to substantiate the period of occurrence and general abundance of each species. Since before the turn of the century Point Pelee has been known as one of the finest migration points on the continent; the peninsula extending southward into Lake Erie acts as a funnel. Its well-deserved fame continues to attract visitors in large numbers; for such field work the booklets should be very useful. The stated aim is to help answer the visitor's question: what birds can I expect to see and in what numbers?

Each booklet encompasses a seasonal period whose arbitrary dates are generally determined by migration periods; unfortunately, migration periods seldom fit neatly into calendar dates. To those of us who are accustomed to the seasons established by *American Birds* (also arbitrary), the variance in this publication causes some difficulty. Certain groups of birds (especially hawks and shorebirds) with extended migration periods may thus be listed in three booklets to show their southward migration. The use of the letter E (earliest) and the letter L (latest) becomes somewhat confusing when the reader must check a species in two or three booklets to determine its migration period. It would be much easier to verify the true migratory status of many species if all the seasonal data were incorporated into one volume instead of four; however, the resulting size would probably be less useful in the field.

The status of the species listed in the spring and fall booklets is amplified by a classifying statement for each (except for the very rare species with a limited number of records). This involves the use of such terms as "uncommon," "fairly common," "common," and "abundant." Although generally helpful, the choice of such distinctions may pose problems. One example is the case of the fall status of the Parula Warbler and Palm Warbler, both classified as "fairly common transients"; the Parula is listed only in numbers from one to three per day while the Palm Warbler was reported in numbers up to 60, 75, and 150 per day. Such data would indicate enough variation in abundance to preclude the same classification.

The author had an unusual number of data, some as early as 1877, on which to base his summaries, including his own extensive field work at Point Pelee. This very abundance of records resulted in some confusion as to the current status of some species. For instance, in the years before 1960 large flocks of Eastern Bluebirds were reported in the fall (many records of 100–800 birds); these figures were used in the booklet and would lead the reader to expect such numbers currently. But in the last 14 years the records of the Bird Survey Committee of the Detroit Audubon Society have shown only one flock of any size, and that of 60 birds. A statement concerning the recent scarcity of that and other species (such as the Eastern Phoebe) would have been helpful. Other recent records reflect additional field work which indicates some species may be more numerous than shown in the fall booklet; one example is the Golden Eagle which has been reported consistently more often since 1963 than shown in the booklet.

A search through the booklets did not reveal the exact date or year of the latest records to be included, but at least one specific record was from 1971. On that basis there are published records of at least two species which might have been included in the booklets: a Red Phalarope in 1969 and a Common Teal in the spring of 1971. Additional records have also been established for the Gray Jay (1973), Common Raven (1970), and Blue Grosbeak (1972). Although the titles of the series (*Spring Birds of Point Pelee National Park*, etc.) seem to limit the lists to the actual park boundaries, the introduction indicates that fine birding areas include the entire point and its shoreline curving toward the east and west. I could find no statement to indicate whether the species lists were made up of birds recorded only within the park or whether some may have been in the immediate environs. For at least one record, the location was along the shore some distance from the park.

From the point of view of a person who knows Point Pelee well, I found the sections of the booklets entitled "Special Ornithological Events" particularly significant and well written. Studying these in seasonal sequence would give the reader an understanding of the special fascination which Point Pelee holds through the entire year for the novice as well as the professional. Anyone who has experienced one of the "big days" described by Dr. Stirrett or watched the hesitant movements of a fall group made up of thousands of Blue Jays would agree these are indeed "special ornithological events." The booklets would be worth publishing for these sections alone. The quotes from the early naturalists such as W. E. Saunders and P. A. Taverner add to the readability of the

series and should send readers to their nearest libraries to read more of the inimitable prose describing the experiences of these naturalists at Point Pelee.

The booklets are attractive, printed in a pleasant, readable type. Typographical errors were most evident in the spring publication. The detailed data on the 326 species listed in the series furnish detailed information to fulfill the purpose of the author.

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Biology of the Kaminuriak Population of Barren-ground Caribou. Part 1

By G. R. Parker. 1972. Canadian Wildlife Service Report Series Number 20. Information Canada. 95 pp. $1.50.

This is the first of four reports scheduled to appear on a two-year study of a population of barren-ground caribou inhabiting northern Manitoba, southern Keewatin, the northeastern corner of Saskatchewan, and the southeastern corner of Mackenzie. Parts 3 and 4 are listed in a manner suggesting they will appear together.

Part 1 consists primarily of movement and population size data, with less information on "recruitment" and mortality. The book begins with the usual introductory material of contents, acknowledgments, a note on the author, and an introduction as well as a perspective and an abstract, the latter in three languages: English, French, and Russian. Earlier Canadian studies on caribou by A. W. Banfield, J. P. Kelsall, and others are regarded as background for this more intensive study of one population.

The short introduction is followed by a brief description of the study area, illustrated by two useful maps. This is followed by an excellent historical review, liberally laced with original quotes containing the original spelling. Parker's discussion on page 23 of this material also serves as an adequate summary of the chapter, allowing readers of less historical interest to skip the bulk of the chapter. Of particular interest to me were the speculation on the identity of an extirpated population that inhabited the area of the lower Nelson and Hayes Rivers, and the conclusion that Banfield probably studied the population at a population high point.

The longest chapter (pp. 24–53) consists of a detailed account of seasonal movements and distribution of various components of the population. Numerous tables and maps greatly enhance the often detailed text. Although well written, many portions of the text may be too detailed and specific to interest many readers, and a short summary at the end of the chapter would have been useful. Within the chapter are several interesting comments or discussions on behavior and selective advantages of certain behavioral patterns. Two of these deserve further comment. Concerning a suggestion by Kelsall that females calve on higher ground to avoid insects and have a better vantage point for observing predators, Parker points out that calving in this population takes place prior to insect emergence, and suggests protection from weather as a more plausible selective force than protection from predators in this regard. This may well be true, but the evidence presented is not sufficient to indicate which of these two forces is more important. Perhaps this varies between areas or seasons or both. Concerning Kelsall's ideas on post-calving aggregations, Parker points out that insect harassment and concentration at natural barriers could not be involved in the Kaminuriak population, as the latter do not exist and the insects emerge after the aggregations take place. Parker, noting that calves and cows predominate in the two eastern segments of the population, whereas males predominate in the third segment, suggests that the grouping serves to concentrate the growing calves in the areas of most nourishment and least insect harassment. This is a plausible evolutionary explanation for this phenomenon, but in no way excludes Kelsall's additional idea that the groupings may be a result of a natural tendency for cows and calves to regroup into larger aggregations after calving. Kelsall's explanation is an answer to "how?" whereas Parker's is an answer to "why?".

The chapter on aerial surveys is again well written and generally well organized, although the problems associated with use of such data are discussed partially in an introductory section and partly in a discussion. As most of the data from these surveys are on movements and/or numbers of portions of the population at various times of the year, I would have preferred to have them discussed and presented in the appropriate sections of the previous chapter.

The titles of two short chapters, "Recruitment" and "Mortality," are misleading. The former includes mortality of young and the latter only mortality of adults, and only mortality by predation. The only predators discussed are wolves and native humans. Sport hunting is not mentioned here, although it is included in the next chapter on total numbers and composition. These three chapters and that following on population status could well have been combined. They are all well written, and although several statements are based on assumptions, these areas of uncertainty are clearly indicated.

My criticisms of this book are all minor. The author has done a commendable job of presenting his own data in relation to those of other studies. The literature cited contains numerous unpublished or obscure reports, making the book a valuable compilation of previous information. As usual in this series, the book is well laid out, abundantly illustrated, and properly proof-read. I failed to find a single typographical error, and only one reference was definitely omitted from the literature cited (Wilk 1958, on p. 43). Three others are either omitted or the wrong date given (McEwan 1957, on p. 43; Pruitt 1958, twice on p. 48; and Thomas 1967, on pp. 13, 66, 67) and two (Hemming on p. 72, and Pimlott on p. 81) should have included more than one author. A minor flaw in the maps results from the use of overlay symbols on previously drawn and labelled maps with the outcome of some place names being partially obliterated.

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The World of the Gull

By David F. Costello. 1971. J. B. Lippincott Co., Philadelphia. "Living World" Series. 157 pp. $5.95.

This cross between a coffee-table picture book and natural history for the general reader is not very good at either, and fails to make a successful hybrid. A basic difficulty is that the author tries to cover too much ground (the world of all species of gulls is very large), but the text is also disorganized, and the photographic quality variable.

The book is a general compendium on gulls of the world, especially those of the northwest United States where the author lives, and includes chapters on activities in different seasons, relationships to man, and species ranges. There is a good deal of interesting anecdotal information, and an emphasis on the beauty and grace of gulls, particularly in flight. The bibliography is quite large for a general book, and covers a wide range of topics. Naming of cited authors in the text is probably wasted on the average reader, however.

The main difficulty lies in the disorganization of the writing. The text as it stands falls much more naturally into categories of flight, food habits, plumages, and habitats than it does into activities by season. It is hard to see the relation of a discussion of gull predation to "Autumn," or of closely related species to "Summer." In addition, the author jumps back and forth between topics and gull species, both between and within paragraphs. Besides being confusing, this style quickly loses the reader's interest.

Imprecise writing is very common in books for the general public, but unnecessary. Examples such as "They [gulls] are cooperative. They find food by watching each other," or "They can walk, fly and swim with ease, which is not true of other birds" (page 15) are not exactly wrong, but misleading. Are other birds supposed to fly with difficulty?

The man-and-gulls section begins by reviewing the exploits of some early explorers and then saying, in effect: these men must have seen gulls, but were too busy to write it down. There is plenty of man–gull interaction to describe without resorting to such tactics. Results of research on gull migration, behavior, cost of flight, etc. are also reported on in this section, presumably because research represents a bird–human interaction, but these would have been more effective in the earlier sections.

The last chapter, listing ranges of the different species, has some of the best photographs. Representative drawings or photos and range maps (rather than verbal descriptions) would have been welcome at the start of the book, so the reader could get oriented to the birds under discussion.

The photos themselves are variable, both in how much they illustrate and in quality. Several are fuzzy, and one exceptionally bad one (of an Arctic Fox) has no gray tones at all. The pictures are often placed far from the text they illustrate, such as the photo of gull eggs in the chapter titled "Autumn."

There is a lot of public interest in gulls, and also a lot of writing on them. Although this book is not all bad, there are better ones: *Jonathon Livingston Seagull* (Richard Bach) for illustrations of the beauty of gull flight; *The Gull's Way* (Louis Darling) for fine color photographs of the breeding cycle; and of course, Tinbergen's *The Herring Gull's World*, a classic which betters all competitors on good information and readability.

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Natural Regulation of Animal Populations

Edited by Ian A. McLaren. 1971. Atherton Press, New York. 195 pp. $3.25.

It may seem strange that in these days of systems analysis and computer simulations, a collection of papers debating the pros and cons of population regulation and the role of density-dependent processes should appear for the first time. These topics are, of course, touched on in other collections, particularly Kormondy's *Readings in Ecology* (1965) and Hazen's *Readings in Population and Community Ecology* (2nd edition, 1970) but neither provides as thorough a coverage of the subject as the present book. Apart from the choice of papers which is appropriate, the chief virtue of this slim volume is the succinct, analytical introduction in which McLaren sets the stage and places each of the contributions in the context of the broader literature dealing with population control. This should be useful to any student of ecology, but readers should be warned that the uninitiated may find the going rather difficult. Following a brief explanation of Lotka's classical equations, McLaren takes the reader through density-dependence and density-independence, social regulation of populations and genetic aspects of regulation.

It seems a little unfortunate that the reader is spared the colorful if somewhat polemical prose of the original protagonists in the density-dependence controversy but their writings can be sampled readily in the 1957 volume of *Cold Spring Harbour Symposia on Quantitative Biology* and references included in the introduction and following the papers in the present book. These early arguments are illustrated and clarified in papers by Solomon and Schwertfeger. A more recent analysis by Horn is included and empirical evidence of density-dependent processes is assembled in Tanner's paper.

The notion that populations are regulated through intraspecific processes affecting the quality and behavior of animals is discussed from several conflicting viewpoints. Thus Christian and Davis emphasize physiological changes in individuals associated with crowding, while Chitty, in a careful analysis of what constitutes critical evidence of regulatory mechanisms, proposes that the quality of individuals in fluctuating populations changes through natural selection. Wynne-Edwards postulates that mechanisms limiting birth rates have evolved by selection between populations and these ideas are criticized in a paper by Wiens. Finally Pimentel's article discusses population regulation through genetic feedback involving two or more species.

The problems of population regulation are by no means resolved and McLaren has done students of ecology a service by providing a balanced selection of pertinent literature together with a useful critique of the field.

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Bees, Their Vision, Chemical Senses, and Language

By Karl von Frisch. 1971. Revised Edition. Cornell Paperbacks, Cornell University Press, Ithaca, New York. 157 pp. $2.45.

One of the "eminent founders of the new science called the comparative study of behavior or ethology" was the praise given when Karl von Frisch was awarded a share of the 1973 Nobel Prize for Physiology or Medicine. This honor alone highly recommends his writings; however this little book on bees is stimulating to read and with its other favorable features it should be of interest to all students of natural history.

The author's ability to present the problems, the methods or approaches to their solutions, and the interpretation and application of the results, in a lucid and concise manner makes the book very readable. The text is clearly printed, in large type, well illustrated and error-free.

The first chapter discusses the color sense of bees, illustrating that bees can distinguish four qualities of color (yellow, blue-green, blue, and ultraviolet), and relates their ability to detect ultraviolet (UV) to the reflection of UV by insect-pollinated flowers. The second chapter treats the chemical senses of bees, pointing out, among other things, that their sense of smell is similar to that of human beings, and describes the simple tests used to classify the taste senses of bees. In the final chapter, which comprises nearly half of the text, the "language" of the bees is explained. The dance they do to "tell" their fellows about the presence of food at a new location is depicted and the importance of the waggle in their walk is pointed out. Finally, the bees will gain from von Frisch's studies because man has begun to entertain the idea that perhaps the bees know what they are doing.

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Birds of Alberta, Saskatchewan and Manitoba

By David H. Hancock and Jim Woodford. 1973. General Publishing Co. Limited, Don Mills, Ontario. 68 pp. $5.95.

Inside the cover a statement reads "Birds of North America Series: is designed and produced by Hancock House Publishers, Saanichton, B.C. Each book in the Series is in two parts. A 48-page section deals with the general facts about birds and appears in similar form in all Regional Editions. The second section of 20 pages which changes with each Regional Edition, deals with the specific facts about birds and birdwatching in that region."

The accompanying text under headings such as Distribution, Classification, Feathers and Flight, Birds and Nests, Migration and Bird Society are adequate only for those who are casually interested in birds. Part I has many photographs, with a minimum of text, depicting some of the groups of birds of the region. Part III, "Bird Watching and More," gives helpful hints to the person who is just getting interested in this pastime. Under "Bird Check Lists" there was no suggestion that the Provincial Museum in each province might be an easier-to-locate source for this convenience. Part IV, "Birding in Alberta, Saskatchewan and Manitoba," contains the most useful information for birders travelling throughout the area, though the nesting Whimbrel on page 55 in the Alberta section might lead one to think it is a characteristic breeding bird of that province, which it is not. The photograph of a Golden Plover at the nest is also misleading for Saskatchewan. "Regina City" is merely Regina on most maps.

Disturbing moments could have been avoided with more careful editing: eg., a photograph on page 14 of a "Flock of Sanderlings" with spotted bellies; the omission of a comma on page 56 creates a new species, a "Great Gray Hawk." Under "Clubs to Join" the Edmonton Natural History Club, Box 1582, Edmonton and the Edmonton Bird Club, Box 4441, Edmonton have been omitted.

For the naturalist who desires a more comprehensive book on the birds of the prairie provinces, *The Birds of Alberta* by Salt and Wilk would be a much better buy, at least for that province. The Saskatchewan Natural History Society publishes many excellent guides to the birds of that province, and certain areas of Manitoba are more competently covered elsewhere.

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Birds of Ontario and Quebec

By David A. Hancock and James Woodford. 1973. General Publishing Co. Ltd., Don Mills, Ontario. 68 pp. $5.95.

This attractive but slender book is one in a new series on birds of North America, designed and produced by Hancock House Publishers, Saanichton, B.C. As the publishers state, each book in the series is in two parts. A 48-page section deals with the general facts about birds and it appears in similar form in all regional editions. The second section of 20 pages, which changes with each regional edition, deals with the specific facts about birds and birdwatching in that region.

The series is obviously aimed at popular birdwatching. There are sections on distribution, classification, flight, nests, migration, bird societies, field guides, check lists and other equipment, Christmas counts and so on. The text is simplistic in style and content but reads quite well. The book's subtitle, "Some of the common and uncommon birds of Ontario and Quebec," is adhered to in the highly selective choice of species illustrated. There are a few splendid color shots among the profuse and generally good illustrations (black-and-white as well), but these are all of little aid in identification.

The most useful section is the guide at the back to good birding locations. But this is no Pettingill or *Naturalist's Guide to Ontario,* being very selective and scanty.

As I progressed through the book, I became less enthusiastic. The endpapers, covered with monochromes of bald eagles, remind us impressively of a vanishing bird. The format and quality of paper and print are pleasing. But close scrutiny soon reveals flaws which may seriously impair its usefulness for the beginner. Photograph 9C is not the eastern race of the Yellow-bellied Sapsucker but either the western race *ruber* or the red-headed woodpecker. The "Sanderlings" in 14B look more like Surfbirds than Sanderlings. A few photographs are off-color: for example, the abrupt blueness on the Black Tern's mantle, p. 11. Gadwall, Goshawk, and Gyrfalcon are misspelled at various points. The Brown Creeper (43D) is not identified. Some county bird lists and clubs are given on pp. 64–65, others omitted. Page numbers are often hard to see in the lower corner of plates or are not given.

The check list at the end is the most disturbing feature. Why are species listed on alternate lines of gray and white

in horizontally consecutive blocks of print which, within each, read vertically? Why, one wonders, are Long-tailed Jaeger (shown on p. 58), Long-eared Owl, Bohemian Waxwing, and Hoary Redpoll omitted, while the western Black Swift, Spotted Owl, and Ferruginous Hawk are included, for which there are no Ontario-Quebec records in Godfrey (1966), the authority followed? A few names, like "sparrow hawk," are inconsistent with the text, where the newer official name of American Kestrel is used.

Finally, although I liked receiving this book as a gift, tailored as it is to a Christmas list, do we need yet another series of picture books on birds? If this series had more real point and accuracy, this reviewer would be better satisified. But I suppose that in this price range there is room for such publications.

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Birds of the Atlantic Provinces

By D. A. Hancock and J. Woodford. 1973. General Publishing, Don Mills, Ontario. 68 pp. $5.95.

The section on "Birding in the Atlantic Provinces" begins with a cartographically careless and ornithologically outrageous discussion of its "Arctic," "Boreal," and "Alleghanian" life zones. Alas, "through poor forestry and agricultural practices, much of the forest cover has been reduced to treeless heather bogs"[!]; but, no matter, for "the meadows of crowberries of each province attract millions [!] of arctic nesting shorebirds"; and anyway, "the greatest feature influencing life in the Atlantic Provinces is not land features but the Grand Banks" [!]. The region has "over 325 bird species" (p. 53), "approximately 350" (p. 62) in Nova Scotia, or perhaps "315" (p. 9).

The guides to bird-finding in each province are fragments from a decade-old series in *Canadian Audubon* magazine, with errors perpetuated and added. We are told to expect Clapper Rails in New Brunswick, breeding Gyrfalcons, Boreal Owls, and Dovekies [!] in insular Newfoundland, Bonaparte's Gull (by implication breeding) in Cape Breton, and a "long-established eyrie of the endangered Peregrine Falcons" on Diamond Island, Nova Scotia. Good luck! And don't get excited by the *European* Whimbrel (p. 59), as the credit is to a British photographer. Where it is not misleading, the text is generally uninformative. Poor P.E.I. merely has beaches that "are good areas for gulls, tern, and shorebirds," and its "mixed farming areas are excellent for warblers, flycatchers, and sparrows."

On the page giving sources of regional information, three of the nine "clubs to join" will not help to "know more about the birds" as claimed. The book and journal references are inadequately documented. Least useful are weather data from 1972 Christmas bird counts.

Finally there is a checklist (333 species) that we are urged to purchase separately. Don't! It is a careless trimming of the excellent Canadian list published by the Canadian Nature Federation. It aims to be complete, rather than representative, as it contains such one-shot goodies as European Coot. Yet I estimate it lacks at least 53 species that have been fully confirmed in the region. Some regulars like Downy Woodpecker and Boreal Chickadee are victims of typographical lapses, as is "White-fronted Goose (incl. Blue Goose)." Other missing ones are far more frequent as strays than are many of those listed. More serious by far is the inclusion of at least 11 species that, to my knowledge, have never been recorded in the area (e.g., Snowy Plover, Steller's Jay), although some (e.g., Violet-green Swallow) may be "hypothetical."

In summary, this is a very bad guide to birds and birding in the Atlantic Provinces. Unfortunately, it will be bought by the unwary because of its convincing cover.

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An Introduction to Animal Behaviour

By Aubrey Manning. 1972. Macmillan of Canada, Toronto. 2nd edition. 294 pp. $6.75.

As all those who teach animal behavior know, there used to be a decided lack of a good introductory text in the subject. In the mid-1960s several attempts were made to fill this gap. Many of these "general" texts were too short, resulting in their being both superficial and narrow in scope. Of the more significant efforts, Eibl-Eibesfeldt's book was highly biased and clumsily produced. Hinde's tome was too detailed and difficult for a one-semester introductory course (except perhaps for those with some background in psychology). Marler and Hamilton's work failed to deal with social behavior and owing to the nature of the material, the book rapidly became dated. Of all these attempts, the first edition (1967) of Manning's book was by far the most success-

ful and was most widely used as a text for one-semester biology courses in animal behavior. The book effectively blended ethology, physiology, and psychology and explained concepts clearly but without deceptively trying to substitute superficiality for reality. Examples and references were well chosen.

The new edition retains all of the book's good points and adds some more. An entirely new chapter has been added on "Social Organization." This fills the major gap in the earlier work. Chapter 4 has been changed greatly and it is probably the best introduction there is to the complex problems of motivation.

The book's well-balanced approach is still evident throughout (e.g., Chapter 9 in which learning mechanisms are discussed in the context of evolution, but the latter is not involved in the heavy-handed fashion of the "classical ethologists" nor, of course, is it ignored as in the "traditional psychologist's" approach). In fact, Manning manages to integrate the different disciplines so well, many students cannot understand how the great learning versus instinct debates ever got started. This is not unusual except that students used to feel mystified because the text only gave one side of the argument; now they see both sides of a pseudo-argument.

About the only criticism one could make of this text is that it does not cover some areas (e.g., orientation) very well, if at all, but then if it did one would be able to claim the book is too long for an introduction. As it is, the book remains an excellent, concise, clear introduction to animal behavior.

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BOTANY

Key to the Quaternary Pollen and Spores of the Great Lakes Region

By John H. McAndrews, Albert A. Berti, and Geoffrey Norris. 1973. Royal Ontario Museum, Publications in Life Sciences. 61 pp., 20 plates (262 photos of pollen and spores), 1 line figure. Keys of pollen grains and spores, and glossary of morphological terms. Available from Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario. $2.50.

For many years the students of Quaternary palynology in Canada have felt the need for an illustrated key to aid them in the study and identification of fossil pollen and spores. Although this need has been partially met by scattered publications that contain illustrations of some pollen and spores, and the more comprehensive reports by R. J. Adams and J. K. Morton, P. Richard, J. G. Ogden, and R. O. Kapp, the "Key" by McAndrews et al. is the first book that provides the kind of information that Canadian Quaternary palynologists have been waiting for.

The authors point out that this key is designed for the identification of fossil pollen and spores commonly found in Quaternary deposits, and that it is most applicable in the middle Great Lakes region but can be useful also outside of this region.

Of the 144 entries in the key, 76 taxa are relatively rare in the fossil assemblages and 46 taxa cover the more common types of fossil pollen and spores. Terminology has been kept to a minimum, and 48 terms have been defined in a glossary. Descriptions of pollen and spores are based on the most useful diagnostic features that can be seen with the aid of a light microscope. Measurements in microns give the range and average size of the palynomorphs described. The nomenclature used follows the *Gray's Manual of Botany*. Only Latin names of the taxa have been used and this may be something of a handicap for some beginning students. One might suggest that a list of common names could have been added to the key. Photographs are of good quality and show the diagnostic features well. Although some line drawings would have been a helpful addition to the morphological descriptions, they would obviously have increased the price of this key, thus making it less accessible to beginning students for whom it is most useful. The present price of $2.50 makes it readily available to everybody.

I have used this key in my introductory course in palynology—and it works. This to me means that the authors must have put their 'product' through 'consumer testing' also and that it can be recommended for use by beginning palynologists, as well as provide a useful reference for all Quaternary palynologists. The beginning palynologist finds this key especially useful because the authors have used their experience to restrict this key to pollen and spores that are likely to occur in fossil assemblages. This means considerable saving in time and effort to a 'neophyte' palynologist who would otherwise have to work through a large volume of palynomorphological literature before narrowing down his final correct identification of a fossil palynomorph.

In spite of the publication of this very useful key the need for additional keys of the same type for other regions of Canada still remains acute. We are still very deficient in necessary basic palynological reference literature (covering modern pollen and spore morphology and taxonomy) that would enable scientists in this field to make use of the full potential of palynological research. There-

fore, it is essential that basic palynological studies such as that carried on, for example, by I. J. Bassett at the Plant Research Institute (Ottawa) be supported and encouraged. Only through such efforts can we reach the ultimate goal—the publication of a pollen and spore flora of Canada. It has been clearly demonstrated that in countries where such basic information is available, palynology can contribute vastly more to paleoecological reconstructions of vegetation and climate and the paleoenvironments, and in biostratigraphic correlation of sedimentary strata than is possible in Canada at the present time. In this respect McAndrews and his co-authors are to be congratulated for reaching an important palynological milestone.

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Our Plant Friends and Foes

By William Atherton DuPuy. 1969. Dover Publications Inc. Published in Canada by General Publishing Co. Ltd., Don Mills, Ontario. 290 pp. $2.35 (paperback).

The Dover reprints, of which this is one, are a very good buy in my opinion, if one is completely aware of what one is purchasing. In these days of inflation when erudite, glossy books, many with color plates, cost over $10 for perhaps 100 or so pages, it is encouraging to be able to pick up a book packed with ''meat'' for less than a ticket to a restricted movie! At the same time, if one puts a premium on the very latest findings in the latest jargon, then these reprints are not for you. This book was originally published in 1930 for a ''fourteen-year-old boy'' and for ''fireside reading for the elderly couple,'' *not* for a professional botanist. Well, this botanist recommends this book for its attempt to popularize economic botany, and he suspects in this day of over-specialization that even the professional botanist will learn or re-learn a great number of interesting things about such important plants as bananas, oranges, potatoes, and wheat. I am sure that a public-school teacher would find many interesting facts in this book to weave into elementary science topics. Chapter 23 on ''The Stately Elm'' with its flowery prose will undoubtedly evoke nostalgia for some readers—''a colossal trunk that might be a column which supports a fountain of the giants that bubbles and spills over in graceful sprays of living green.'' This sort of thing undoubtedly dates the book, as does a small sketch which has the caption ''The salty water from ice cream freezers kills the trees in front of drug stores''! This is not the only reason that trees are missing in front of drugstores! But the botanical history of such plants as navel oranges, potatoes, beans, cotton, and rubber trees, for example, has *not* changed and it is refreshing to see it written up in a simplified and popular way.

The emphasis is certainly more on the ''friends'' than the ''foes.'' Poison ivy, daisies and dandelions, and some rusts, however, are given passing mention. The main thrust of the book though, is on the history of economic plants and their utilization, with the plants grouped conveniently into broad family groupings such as the pine family, the mallow family, and the grass family.

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ENVIRONMENT

Environment on Trial—A Citizen's Guide to Ontario Environmental Law

By David Estrin, John Swaigen, et al. 1974. Canadian Environmental Law Association, Toronto. 409 pp. Paperback, $2.95.

Despite every effort of the Ontario Government, there remain practical avenues through which the citizen can take legal action against polluters and despoilers of the environment. This is the central message of *Environment on Trial*. This book is not light reading, it is not easy reading; every Canadian should have a copy (there is plenty of material on Canadian law and on the law of other provinces, as well as on Ontario law). Mr. Estrin and his associates are to be congratulated on a truly monumental effort. In essence, the book tells you what laws are available, under which the citizen can bring action against polluters and against lethargic government agencies that are not acting against polluters. Practical instructions are given on how to avoid personal financial ruin in the process. There are also many pointers on actions citizens can take which don't constitute legal action in the strict sense and yet might be quite effective in prodding reluctant bureaucrats to do what the citizens have hired them to do. For example: many

citizens are suffering and will suffer extreme inconvenience due to gravel quarry operations. While gravel is absolutely vital to the functioning of our society, such as it is, most of these inconveniences can be prevented. Mr. Estrin and his associates have 'unearthed' the facts that all heavy trucks operating on unpaved roads require special permits, and of course that there are weight limits on all roads. Gravel trucks rarely have these permits and are frequently overweight. Instructions are given in the book on how to determine the identity of the legal owner of the truck, how to determine the weight limit for the particular road involved, exactly which municipal and provincial government offices to call to determine whether a permit has been issued, and how to prod the police into acting or how to bring an action yourself against illegal trucking operations (i.e., those without permits and those overweight). This kind of harassment is likely to make better citizens out of gravel operators. The book claims that some of the officials you will deal with in this process will be almost totally ignorant of the laws involved here, laws they themselves are supposed to be enforcing.

Another example: everyone has heard of the program approvals and control orders used by the Air Management Branch (AMB) of the Ontario Department of the Environment in dealing with air polluters. This approach is famous or infamous, according to your predilections. An air polluter and AMB sit down together and work out a program according to which the emission of pollutants will be reduced by such and such stages on so and so dates. If a "program approval" satisfactory to both sides cannot be worked out, then AMB will issue a "control order" which does the same thing, but with slightly stronger legal teeth. The flaw in all of this is that there has been no opportunity for someone residing near a polluting factory to have a say in how much pollution is bearable or how fast the polluter should be forced to reduce his emissions. Also, AMB has been very secretive about the texts of the program approvals and control orders.

Environment on Trial tells us, however, that citizens who somehow can find out that a program approval or control order is about to be issued can write to the Minister of the Environment and insist that he be allowed to see the proposed approval or order and supporting data before issuance.

A polluting factory which disagrees with the provisions of a control order can lauch an appeal before the Environmental Appeal Board. In an outstanding example of the efforts of the Ontario Government to shut citizens out of the environmental field, citizens have no *right* to appear before the Appeal Board during an appeal by a polluter. But the book advises us that the "Board may *suffer* citizens to appear, and thus, if citizens are aware of the polluter's appeal, they should demand an opportunity to make their views known."

The book goes on to provide an important fact of which I personally was not aware, and that is that program approvals and control orders are public documents and "are available for public inspection by any person who knows the name of the company, business, or individual against whom the order was made." The authors have even brought to light an obscure provision which obliges the government to provide copies of such documents to the public at a cost of no more than 10¢ per 100 words. Also, a private citizen can bring legal action for failure to comply with a program approval or control order.

These examples don't even scratch the surface of the wealth of information available in this book. The complexity of the legal remedies precludes complete description in a brief review. But the material is by no means incomprehensible and the rewards are great for the reasonably diligent reader of this book. Be one.

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Wild Rivers. A Proposal for Wild, Scenic and Recreation Rivers in British Columbia

By G. Warden and E. Malenkow. 1973. B.C. Wildlife Federation. 24 pp.

"Let us move now to retain all the natural attractions of at least a few of our streams, while the opportunity is still with us." — Chilko Dredgers Wildlife Club, 1968.

We, the public, are being made aware of a problem which will ultimately affect almost all of us directly, or indirectly through our progeny as a result of the writing of *Wild Rivers*.

This concise and well-written booklet expresses a point of view in an interesting and readable form. The text is supplemented by fine maps and excellent interpretive photographs. It deals with the passing of legislation to protect rivers in as natural a state as possible. Existing rivers are categorized as follows: (1) "wild river areas — those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted . . ."; (2) "scenic river areas — those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but ac-

cessible in places by roads . . ."; (3) "recreation river areas — those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past . . . ." These categories are illustrated by excellent examples of existing British Columbian rivers.

Any attempt to save wild rivers is an extremely worthwhile project and its supporters are to be highly commended. As we look around ourselves, with respect to natural waterways all over the world, it becomes evident what will happen if man continues to proceed as he has in the past. Legislation is a necessary step to protect man from himself and his actions. It is much easier to prevent the destruction of a watercourse than it is to try to repair it afterwards. If we hope to have any free-running rivers and streams — clean and alive — for future generations, we must act now to protect them or they could be lost forever. If you wish to help preserve wild rivers, write for this booklet to B.C. Wildlife Federation, 17655 57th Avenue, Cloverdale, B.C.

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The Peace-Athabasca Delta: A Canadian Resource

By the Peace-Athabasca Delta Project Group, Environment Canada, Ottawa. 1973. Queen's Printer, Edmonton; Queen's Printer, Regina. 144 pp. $1.00. (Available from Information Canada bookstores.)

The Peace-Athabasca Delta is important in northern America for the following reasons: (*i*) it is not only one of the western hemisphere's most extensive boreal or northern inland deltas, but also one of the continent's last relatively undisturbed deltas; although located in a northern clime, it comprises a varied and rich environment of flora and fauna; (*ii*) it is a key link in the four major flyways for migratory birds, an important breeding area for ducks, and a nesting area for the endangered peregrine falcon; (*iii*) it contains the largest area of undisturbed sedge and grass meadows in North America and provides the grazing lands for most of the 14,000 bison inhabiting Wood Buffalo National Park.

In 1968 the W. A. C. Bennett Dam was constructed, which effectively controls 50% of the flow of the Peace River at its point of confluence with Lake Athabasca. This dam resulted in reduced flooding of the wetlands and consequent drastic ecological changes which necessitated serious investigations. The key to the Delta's unique character had been the recurrent summer flooding followed by a recession of water in the fall and winter. This fluctuation in water levels had fostered an environment in which plant and animal life had achieved a balance dependent upon the frequent flooding. During the summer flooding, both the Delta's groundwater system and the numerous ponds and marshes were recharged. In the late summer and fall, groundwater began to recede. Since the relatively impermeable silty clays of the Delta severely limited the lateral movement of water from the major lakes and streams into the surrounding subsoils, flooding was essential to maintain groundwater levels and perched basins.

The report is divided into 10 chapters encompassing various aspects such as plant communities, wildlife, fish, social and economic studies to assess the impact of changes in water levels on the income and life style of the local people, navigation and water-transport in the region, legislation relating to water management, measures to save the original ecological character of the Delta, and government responsibilities. Five categories of plant communities — aquatic, shore, meadow, shrub, and forest — were found to be in a continual state of transformation. The habitat types on the Delta include mud flats, ferns, meadows, low shrubs, tall shrubs, deciduous forests, coniferous forests, and rock outcrops. Waterfowl, muskrat, bison, and moose are common. The fish population is mostly of goldeye, walleye, northern pike, lake trout, and whitefish. The local inhabitants make their living by trapping, forestry, barging, and fishing. Mineral resources include gypsum, granite, gold, and uranium.

This report provides a comprehensive, schematic survey of the Delta which will be useful to conservationists, ecologists, naturalists, wildlife managers, and senior biology students. The changes brought about by reduced water levels are vividly presented and the effects of a modified regime predicted. It has good colored photographs and no printing errors. A list of flora and fauna would have been useful, however. In all it is a welcome contribution to environmental studies in Canada.

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One Cosmic Instant: A natural history of human arrogance

By John A. Livingston. 1973. McClelland and Stewart, Toronto. 243 pp. $7.95.

In the past decade there has been a surfeit of books with this general theme, many of them with little or nothing to offer. If John Livingston had not authored this book I might have passed it by. But Livingston is a naturalist and conservationist well known for his fine work in radio and television, particularly the CBC television series ''The Nature of Things''; and for such books as *Birds of the Northern Forest* and *Birds of the Eastern Forest*. So I read the book. I like it.

The subtitle of the book, ''A Natural History of Human Arrogance,'' conveys the theme of the work. Livingston has experienced all the ''frustration, dismay, and varying degrees of anger. . . .'' experienced by all ecologists at the realization that man, in his arrogance, generally assumes absolute power and authority over nonhuman nature. Western industrial man is the root cause of environmental distress, says the author. But in a sense it is not modern man's fault since man has been programmed through his culture to act this way.

The book begins with a clear and concise description of formation of earth and atmosphere, and the development and acquisition of life on this earth, the only earth we can hope for. Following that is a discussion of community, population dynamics, territoriality, predation — a well presented and current treatment of ecological principles. There is a description of the appearance and evolution of man, and the point is made that being bipedal creates a feeling of superiority and power. The development of social life of hunting man fascinated me again here as it always fascinates me whenever I consider this important time in the development of our species. Hunters were the first naturalists and ecologists, but it was also hunting man who first regarded nature as a force to be dealt with and to be overcome (if necessary) for the good of man. Man considered himself apart from nature very early in his development; and with the attention given to fertility (of animals, of plants, of people) by early man it is apparent that man has always sought to overcome nature by sheer pressure of numbers. As Livingston says, ''it is no wonder that even in the twentieth century it has been difficult to overcome ancient taboos in connection with limitation of human numbers.''

By the Renaissance man had developed sufficient technology to realize the world was conquerable. Livingston considers the voyages of exploration at this time to rank with the period of Pleistocene overkill as disastrous to wild nature. And, as he further says, the ''current technological orgy . . .'' was to be expected.

There are discussions of man's reason, romanticism, insensitivity, and arrogance as components of man's culture. The curve of cultural evolution rises exponentially, and once it got under way no adaptation in nature evolved so rapidly. In comparison, biological adaptations were slow and could not compensate for the cultural drive to rule nature. Livingston is convinced that unless man consciously forges a change in cultural direction, adopting a ''new and unprecedented humility toward the cosmos of which we are an integral, mortal part . . .'' there is little hope for the survival of nonhuman nature. He ends his book with this paragraph:

> There is no engineering answer to a problem created by culture. The worst in humanistic ways of thinking opened and kept open the conceptual man/nature dichotomy, and only the mature wisdom and insight that characterize the best in the natural philosophic tradition can mend it.

This book is a powerful personal statement by John Livingston, at present a member of the Faculty of Environmental Studies of York University. In his fine prose style he puts together material that is familiar to most current ecologists and makes it ring with concern and with truth. I could argue with him on some statements, but more for the pleasure and stimulation of it than for anything else. I would refer him to ''Meditations on Hunting'' by Jose Ortega Y Gassett for discussion of why some men continue to hunt in our time. I would suggest that he is perhaps too dogmatic in some of his statements; in interpreting some of the archeological findings, for example. But generally I would cheer him on.

Livingston has read widely, and the writings of many scholars and students of the human species find their way into his book. A bibliography of 131 titles is a valuable addition. I was also pleased to see a fairly complete index.

Three lines by William Blake open the book:

> When the stars threw down their spears,
> And water'd heaven with their tears,
> Did He smile His work to see?

John Livingston does not smile when he views the world. The photograph of the author on the back of the dust jacket shows a man looking ahead and grimacing in controlled disgust; a man viewing his world and finding it wanting.

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Arctic Microclimates

By P. S. Corbet. 1972. The microclimate of arctic plants and animals, on land and in fresh water. Acta Arctica 18. 43 pp.

This is a very clearly written general review of arctic micrometeorology that brings together North American information to about 1970 and serves as an extrapolation of Geiger's (1966) *The Climate near the Ground* into arctic areas. I believe the author has attempted to provide a review useful to any biologist who has a general understanding of meteorology rather than to provide a highly quantitative view of arctic meteorology. The 128 references in the present work will serve as a beginning point for a student new to the field.

Corbet's research at Lake Hazen, Ellesmere Island (81°49′ N) since the mid-1960s prompted him to write this review. The now-published work from Hazen Camp, by himself and his colleagues, is incorporated. Almost all of the 23 figures come from work completed at other research sites and already published in research journals. As with all summaries on arctic research, this one is already out of date. A good deal more information is now available from the International Biological Programme studies at Char Lake on Cornwallis Island, on Devon Island, and at Point Barrow, Alaska. Some of the questions raised in the review have been answered and many more quantitative data are now available from these studies.

The author has logically divided up the review into general arctic microclimates, below-ground microclimates, and freshwater microclimates. Within each of these major sections a short description of the biota and major seasonal limiting features is provided. With this as a background the microclimatic factors of temperature, moisture, and wind are examined to give the reader an understanding of the spatial and temporal variation. Although focus is on the physical factors, responses of organisms are included. The author defines plants and animals mainly in terms of flowers and insects, because much of the Hazen Camp research with which he was associated was so oriented. I feel that he would have strengthened his paper for general readers by including examples from other divisions of macro- and micro-organisms. A few photographs illustrating points in the text would likewise be useful.

Since biology is becoming more and more quantitative and predictive, I initially expected to find some references to preliminary mathematical or world models of micro-meteorological phenomena. Quantification of physical parameters such as thermal conductivity of animal pelts and resultant winter survival, or thermal conductivity of soil and resultant microbial activity, would have made the review more useful for researchers. Perhaps the author felt that he had to leave out the more quantitative aspects to retain the general readership, but I hope he can be encouraged to attempt in the near future a larger, more quantitative review including the Old World literature. Many arctic researchers would welcome such a work.

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Clearcut, The Deforestation of America

By Nancy Wood. 1971. A Sierra Club Battlebook, Sierra Club, New York. 151 pp. $2.75.

Controversial books often advocate the extreme and hence are ignored by but a few. Ms Wood's book is an exception. She has effectively organized and presented pertinent material on forestry practices in the United States in a clear and factual way.

The text is organized into eight chapters, preceded by a prologue and followed by an epilogue. The prologue introduces the text by suggesting what the reader may have personally experienced — "a virgin forest, growing by itself without man to manage it or decide its fate, a forest which has not yet been humbled, a forest which has no 'use' except to those who come to gain some insight from it." The epilogue reads as a confession from a logger who has realized that, with his axe, he has destroyed one of life's few but undefined pleasures: "I am deeply concerned about our forests . . . they are going, going, gone. . . . Gentlemen this is all there is. There is no more and the time is running out."

In the main body of the text are two noticeable features. First, Ms Wood has a remarkable ability to organize coherently a large volume of factual material into readable order. Secondly, she shows absolute confidence in her material, accrediting numerous quotations to specific, named individuals rather than to 'a company spokesman.'

The controversial issue of clearcutting or even age management has been dealt with by a wide range of publications, including *Reader's Digest* (September 1971) and the *Journal of Soil and Water Conservation* (1972, 27(6)). For all the attention, the arguments and controversy continue.

Ms Wood makes no disguise of her opinions regarding the cutting procedures practised in the United States. Her principle objection, however, is to the invasion of

the United States national forests by timbering interests. "The American forest is a battleground. On one side is the timber industry. Having overcut its own lands, it now seeks to raid the national forests where half the remaining softwood supply stands. On the other side are individuals from all walks of life who believe that the national forests belong to the people and who decry the fact that each year one million acres of wilderness fall to industry's chain saws. In the middle is the United States Forest Service."

The United States Forest Service, according to Ms Wood, is not acting in the public interest. "The service virtually ignores all other values when timber is in question. Recreation, wildlife, watershed protection are given sparse attention."

Within the text there is allusion to the timber industry operating along the lines of big business. "The Company (International Paper Co.) will set up the harvest of timber from its own forest lands and begin to maximize profits by treating the land as current profit centers rather than resource banks for future use." The industry justifies the invasion of public lands by maintaining that it is opening new areas for visitors and harvesting a crop which would otherwise rot and be lost to man. Several companies that publicize tree-farming operations claim that their reforested areas are more attractive than disorganized mixed natural forests.

Although industry maintains that there is a timber shortage, the volume of timber materials being exported to foreign markets is increasing every year. "The strange thing about the intensity of export in 1968 was that it was done at the expense of business at home." Yet waste continues, principally as the non-utilization of slash, with industry making no real effort to use this material. Documentation suggests that this waste, if 'harvested,' could increase the harvest by ten percent.

Generally speaking, the book is easily readable and highly recommended to all persons concerned about the future of natural resources. Although Ms Wood deals exclusively with the United States forestry scene, the problem of clearcutting is North American in scope. One company justifies it by stating that by removing the forest, the public can see the view. Hopefully, the view shown by Ms Wood will have as much public appeal.

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Environmental Quality and Water Development

By C. R. Goldman, J. McEvoy III, and P. J. Richerson. 1973. W. H. Freeman, San Francisco. 510 pp. $17.50.

This book is a compilation of 28 articles contributed by different authors. Useful references are given at the end of each article, together with a summary or conclusions. The opening chapter begins with recommendations submitted to the National Water Commission. W. Everson in Chapter 2 explores the spiritual, mythical, and emotional aspects of man's relationship with his environment; this is followed by a review, particularly of the history of water development in the United States, by L. A. Teclaff and E. Teclaff.

The importance of national policy in establishing national parks, reserves, wilderness and watershed protection areas is stressed in most of the articles, and a gamut of recommendations is offered to protect the environmental quality. Topics are quite varied, encompassing physical, chemical, economic, aesthetic, and social conditions. J. A. Swan holds the view that man's ability to adopt psychologically to conditions may cause physiological harm, and some natural areas must be preserved intact as a baseline for judging environmental quality. Dynamics of ecosystems in general are discussed, while the biology of estuaries and the ways in which they can be disrupted by human influences are dealt with in detail. Much importance is attached to decision-making networks, the government machinery at local, federal, and international levels, the role of the technical expert, and the establishment of ombudsmen to protect the rights of a citizen to preserve nature. Comprehensive case histories which include those of the Great Lakes, Lake Washington, Skippack Watershed, etc. are presented and discussed in relation to man's effects, eutrophication, and detrimental aspects that upset the ecological balance.

The whole work is well produced and commendable — an ideal textbook covering the essentials of environmental quality and water development. For the most part the outlining, referencing, and content of the work are sufficient for its scope and purpose.

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Seashore and Sand Dunes

By S. M. Evans and J. M. Hardy. 1970. Heinemann Educational Books Ltd., London. 86 pp. (paper). $2.00 from Bellhaven House, Scarborough.

This small book of the "Heinemann Investigations in Biology" series is intended to introduce the student at the advanced high school or university undergraduate level to "the kinds of problems that have interested marine biologists and the ways they have devised to solve them." A total of 23 investigations are presented over six chapters covering the following topics: adaptations to life on the seashore; feeding; parasitism and commensalism; microhabitats; life in estuaries; and sand dunes. The inclusion of this final chapter will be of interest to those involved in plant ecology but not especially in marine biology, for the sand dune investigations may be applied to sand dunes whether they are at the seashore or far inland. Nine photographic plates and 21 figures consisting of line drawings of apparatus and organisms, and of graphs illustrate the book. The text material is further supplemented by seven tables. A four-page index will aid the reader in locating references to species, authors of scientific papers, and to subject material.

The investigations presented have been used, with the exception of one, by the authors in their work with students, and they involve relatively simple apparatus. Investigations involve such techniques as oxygen determination in rock pools; determination of water content, humus content, salt content, pH and carbonate content of sand dune soils, to mention only a few. References to scientific papers for further reading are given at the end of each investigation. The organisms selected for investigation are common and easily identified species but are British species, for the book is written for the British Isles. This but slightly lessens its value to the beginning marine biologist on Canadian shores, however, for although the species will differ the principles involved will not.

In my opinion this book adequately fulfills the aim of the series which is in part "to provide ideas for investigations and projects in specific fields of biology."

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The Olympic Rain Forest

By Ruth Kirk. 1973. University of Washington Press, Seattle. 86 pp. Cloth $8.95; paper $4.95.

The Olympic Rain Forest is situated in the Pacific Northwest of the United States, principally in three main valleys — the Hoh, Queets, and Quinault. The bottom lands are a mile wide and level to the base of the walls. The valley gradients gain only 600 feet of elevation in 20 miles. The river that passes through these valleys can rise six feet in a day's downpour. Glaciation is responsible both for the broad valleys and the braided river channels, and apparently this physiography holds the key to the development of rain forest. Geologists find evidence of four successive glaciations in the Olympics, the oldest within recent times having ended over 70,000 years ago and the youngest about 11,000 to 15,000 years ago. The precipitation ranges from 120 to 140 inches and temperatures from 104°F to −1°F, recorded at Quinault.

A theme of the book is plant succession, discussing the flora of more than 300 species. The most common genera are *Picea, Pseudotsuga, Thuja, Populus, Alnus,* and *Acer*. The shrub layer is of *Salix, Sambucus, Rhamnus, Rubus, Vaccinum,* and *Oplopanax*. Ground cover is rich in mosses, liverworts, ferns, fungi, and herbs. Snakes, insects, myriapods, and mollusks are not uncommon. Mammals include beaver, chickaree squirrels, elk, deer, bears, cougar, bobcat, raccoon, otter, and skunk; birds include chickadees, warblers, vireos, and kinglets.

This book has 100 excellent photographs produced in black and white, and color as well. It is free from printing errors. The text is not studded with difficult technical terms and can easily be read by anyone who is interested in knowing what a rain forest is like.

C. R. CHEVENDRA

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OTHER BOOKS

Wilderness Gear You Can Make Yourself

By Bradford Angier. 1973. Stackpole Books, Harrisburg, Pennsylvania. 115 pp. $6.95.

In a society where life begins at five p.m. Friday, where we find ourselves bored with the routine of the work week, where we find ourselves with increased leisure time on our hands, many of us want to turn 'back to nature' but do not know how. Perhaps Mr. Angier can help us attain our goal through his latest book.

Bradford Angier, a well-known outdoorsman and survival expert, has brought to us in this book, and in his previous books, a ready reference that will certainly make our stay in the bush more enjoyable and comfortable, and one that could possibly save our lives some day. He has included directions on how to construct many easy-to-make conveniences which will make the most remote campsite seem more like home.

The book is divided into several chapters, each dealing with some aspect of camping gear or survival in wilderness forests and deserts. He talks first of equipment required to get your gear into the campsite—packboards, packs, and panniers. Once you reach your camp, he tells how to make shelters, fires, torches, heaters, stoves, and camp furniture. The manufacture of clothing, belts, shoes, sunglasses, and splints completes these chapters. The making of tools, hunting and fishing gear, weapons, and traps are also described.

Finding water in a desert or getting 'unlost' are difficulties we often face at one time or another in the bush. The author discusses methods for doing these that have saved hundreds or even thousands of lives over the years.

Finally he talks about more elaborate gear that is probably better attempted as a home project rather than at camp. He tells how to make a plastic canoe for about ten dollars or a raft or a logboggan. However elaborate these may sound, they could someday be the difference between life and death for a lost or stranded traveller.

There were several details lacking in the book. Most of the diagrams are not titled or referenced, occasionally making it difficult to follow the text. On at least two occasions, diagrams are incompletely labelled or inaccurately referenced. On page 16, the author talks of "BB-loops or cords . . ."; these are not labelled on the accompanying diagram. On page 89, Figure 3, the author refers to cutting "the feather in the shape indicated in Fig. 3." The cutting of the feather is actually seen in Figure 4, page 90.

Generally though, the book is an excellent guide to making wilderness gear. The diagrams, easy-to-follow step-by-step directions, comprehensible vocabulary, and Mr. Angier's pleasant style of writing make it easy for the pro or the novice to make the articles described.

The book represents a worthwhile endeavor and is highly recommended to the weekend camper or the hardened woodsman.

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Animals and Man in Historical Perspective

Edited by Joseph and Barrie Klaits. 1974. Harper and Row, New York. 169 pp. $2.95.

This attractive anthology is comprised of eight essays dealing with the way man has treated or regarded animals down through history. Two articles deal with animals in captivity, three with animals in domestication or as pets, and three with religious and/or humanitarian ways of looking at animals.

The articles on zoos include a section from Hediger's classic *The Psychology and Behaviour of Animals in Zoos and Circuses* (1955) in which he considers the extent to which zoo cages can and should be fashioned to conform to the inhabitants' innate behavior patterns. A less familiar essay by Ellenberger correlates our historical treatment of animals in captivity with that of insane people in mental hospitals. Indeed Montezuma in Mexico kept dwarves, hunchbacks, and albinos each guarded in separate rooms near the zoological building where Cortez wrote of "long halls adorned with grill-work cages carved in solid wood, and inside, lions, tigers, wolves, foxes and cats of every species, all in great number." Whereas in zoos the trend has been from princely private menageries, to public zoos replete with bars, to modern moated zoological parks where natural animal behavior can be observed, the development of psychiatric institutions has been the reverse. Presently they are almost hermetically sealed from the public, but in the seventeenth and eighteenth centuries many asylums were places of public entertainment. On an average Sunday 300 people paid a penny each to visit Bedlam Hospital in London. "The visitor, after checking his sword in the vestibule, had the right to wander through all the wings, look in all the cells, speak to the patients and make fun of them. In exchange for their

rejoinders, . . . he might give them alcohol to stimulate them further.'' Today zoo animals sometimes attract cruel reactions from the public as mad people did centuries ago.

Norman Brown's essay on the unity of life as envisaged in Indian religions, in which all life is revered, and as a consequence, vegetarianism is a religious necessity, contrasts intriguingly with Lynn White's essay on animals and man in western civilization. White delineates man's unnatural treatment of nature, which has resulted in the ecological crises which now face us. Largely to blame is the arrogant Judeo-Christian tradition which places man above his environment, rather than as part of it. The rise of science and technology has allowed us to manipulate plants and animals sometimes to their own extinction and to our future poverty.

This anthology ends with an informative article by Zeuner on the history of domestication of animals and with one by Turner on humanitarianism. Humanitarianism towards animals closely parallels that towards human beings. The same generation of Englishmen who were hanging petty thieves thought little of whipping cart-horses unmercifully or of dissecting dogs while they were conscious. Yet by 1800 there were a few cranks who advocated kindness towards animals, an occasional vicar who forebade boys to rob birds' nests, or an eccentric woman who succoured stray cats. The nursery rhymes about mice docked by carving knives and blackbirds baked in pies were joined by new propagandist ones: ''Mary Had a Little Lamb'' published in 1830 and ''I Love Little Pussy'' ten years later. The trend is still continuing today, when hunters continue to give up shooting to become nature photographers. Perhaps in the future we will rebel against fish being impaled on hooks and skinned alive. I hope so.

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The Lysenko Affair

By D. Joravsky. 1970. Russian Research Center Studies 61. Harvard University Press, Cambridge, Massachusetts. 462 pp. $13.95.

This book analyzes the interaction of Soviet agriculture, natural science, and political power since the 1920s. In those early days the communists left natural science to the scientists if the scientists would leave politics to the communists. The whole metamorphosis of agriculture in Soviet land is traced, including all percussions and repercussions right from Michurinism — fruit growing and methods of breeding. In 1928 Lysenko tried to correlate data on growth, calendar days and degree-days, and stated that chilling of the germinating seed for a minimum number of days was the sole determinant for growth. At the same time, vernalization seemed to be his discovery. By 1939, Lysenko, the chief agrobiologist was the undisputed boss of all biology and all its agricultural applications. Genetics was totally suppressed. That was the ultimate victory of the practical Stalinist approach to scientific agriculture and a self-defeat as well because, within few years, Stalinists found it necessary to dislodge Lysenko by opening genuine discussions. The climatic triumph of Lysenkoism was reached in 1948. Later on, Lysenko's weak points: (1) the denial of natural selection within a species, and (2) the claims of sudden transformations from one species to another, were criticized. Advances in cytology, plant physiology, breeding, and soil science were against him. It took about 11 years for Stalin's successors to change their minds completely about the usefulness of agrobiology during the 1950–1965 period, though Lysenko struggled hard to retain his influence. The agricultural establishment removed the highest political figures from agrobiology in the 1960s, just as it had done in the 1930s. The press was filled with anti-Lysenkoite articles and appeals for the restoration of fully autonomous, scientific methods in all fields of biology and agricultural science. (Lysenko believed that his work should not be verified, thus no one could prove him wrong.) The final fall of Lysenko occurred in 1965, on the eve of Khrushchev's overthrow.

Lysenkoism in the light of Lamarckian doctrine, Darwinism, and Mendel's genetics is also discussed in this book which has about 150 pages of valuable appendices, bibliography, notes, and index. The appendix includes the names of repressed specialists and Kremlinologists of Soviet regime. Joravsky must be congratulated for bringing out this excellent work with its great detail to chronology. The book forces one to realize to what extent politics can play a role in shaping the destiny or advancement of science. I greatly enjoyed reading this wonderful piece of work.

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The Red Gods Call

By Paul L. Errington. 1973. Iowa State University Press, Ames, Iowa. 171 pp. $5.95.

Essentially autobiographical, *The Red Gods Call* is a collection of reminiscences and reflections by a man, late in life, recalling his youth. Paul Errington's anecdotes are often amusing, presented with a format not unlike that of Aldo Leopold's *A Sand County Almanac*.

The book is separated into two parts. Part one tells of a boy whose keenness perhaps exceeds his time-tempered ability to deal with nature in winter. It ends with youthful recognition that experience can come only with time. Part two begins "So I went back home to grow up some more . . ."

Although the Preface was a valuable addition to the text, I felt that the Epilogue was not. Rather than leave the book on its casual and easy-going note, Errington chose to include a message: ". . . in brief . . . my idea of what a wilderness preserve in a man-crowded and man-tampered world should mean: a living, natural museum of immense scale dedicated to the perpetuation of the unique values that man can much more easily ruin than restore." This message, included as an epilogue, causes the reader to wonder whether this is the moral realized by the man upon reflection of his youth, or whether the author is simply trying to justify his hunting and trapping activities.

Generally speaking, the book is light and easy reading. Occasionally biological principles tend to appear, semi-disguised, as the young man's growing awareness: "And I began to see vaguely that there were rules of order behind natural relationships" (p. 47); "A wilderness need not be full of game and fur merely because it is empty of people" (p. 109); ". . . biological excesses that must come to a natural termination somehow . . ." (p. 155).

The Red Gods Call is not meant to be educational or academically appealing; rather it follows the 'Huck Finn' approach to enjoying the out-of-doors. Unfortunately the author's scientific style of writing is still present and although he attempts to adjust to a less precise and easier-to-read style of writing, he doesn't quite make it.

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On the Edge of the Shield: Fort Chipewyan and Its Hinterland

Edited by John W. Chalmers. 1971. The Boreal Institute of Northern Studies, Publication Number 7, University of Alberta, Edmonton. 60 pp. $2.00.

This booklet describes the influence Fort Chipewyan had on the exploration of northwestern Canada. Fort Chipewyan, originally established as a fur-trading post second only in importance to Fort William or York Factory, played an important role in providing food for the fur traders. It was inhabited mainly by Métis, and Cree and Chipewyan Indians. Such notable persons as Sir Alexander Mackenzie visited the fort and Sir John Franklin, the famous Arctic explorer, got provisions there in 1820 on his way north to search for the North West Passage.

The prosperity of the area decreased sharply after the height of the fur trade had passed. By 1930 the plight of the Métis had become acute; since they were neither Indians nor white no land had been set aside for them on reservations. They had little education and the spread of homesteaders was a threat to them. The Alberta government tried to encourage the Métis to live in farm colonies, but they had no desire to become farmers. During the 1960s improvements such as the telephone, an airstrip, and an addition to the school came to Fort Chip.

The booklet also deals with the effects of the Bennett Dam on the Peace-Athabasca Delta at Fort Chip. The dam lowered the water levels at Fort Chip so that many of the marshes and sloughs are drying up. It has meant the death of Egg Lake, which was one of the best muskrat lakes in the Delta, while other, larger lakes have increased in size dramatically. This change in the water level has exposed fish spawning beds and dried up migration routes for fish, as well as reduced waterfowl breeding and resting areas, and destroyed muskrat habitat. It may even be reducing the carrying capacity of the surrounding meadows for buffalo. No research had been done before permission was given to go ahead with the Bennett Dam.

Lastly, the booklet deals with the aims and structure of the Boreal Institute for Northern Studies. This set of six broadcasts by University of Alberta faculty members gives an interesting and highly readable account of Fort Chip which had a glorious and exciting beginning, but through man's thoughtlessness may well have a sad ending.

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Biology

By Claude A. Villee. 1972. Sixth Edition. W. B. Saunders, Toronto. 915 pp. $11.60.

Dr. Villee has approached the difficult task of writing a general biology book in a comprehensive and effective manner. The text is complemented by the use of many excellent illustrations which are both interesting and informative. While a continuity is established throughout the book, each of the chapters can be considered independently, thus not restricting a teacher who does not want to follow their order of presentation. A great asset of the book is the inclusion of questions and supplementary readings at the end of every chapter. The questions are thought-provoking and re-establish major points made in the chapter.

The first two chapters of *Biology* give an adequate introduction to the major unifying concepts, doctrines, and theories of biology and the methodology of biological investigation. The remaining 36 chapters are divided into eight parts: 1. Cell structures and functions; 2. The world of life — plants; 3. The world of life — animals; 4. The organization of the body; 5. The biological basis of behavior; 6. The reproductive process; 7. Heredity and evolution; and 8. Ecology. In this new edition chapters on behavior and human ecology have been added and revisions of the chapters concerned with cell structure, intermediary metabolism, endocrinology, bioenergetics, sense organs, autoecology and synecology have been made. The discussions of molecular biology, the genetic code, protein synthesis, and the principles of evolution have also been revised and enlarged. A brief classification of plants and animals is included at the end of the book, as well as a glossary of important terms used in the text.

The massive amount of information covered by Dr. Villee has made the textbook rather unwieldy for a student who needs only a general background in biology. It is recommended to serious students of biology for use in an introductory biology course at the university level, and to members of other professions, especially teachers, who need a good resource book in biology.

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Who Wakes the Groundhog? Early risers and late bloomers in the natural world

By Ronald Rood. 1973. W. W. Norton, New York. 206 pp. $7.95.

It was shortly before the time of Aristotle that an amateur naturalist observed, and reported on, what today we call biological rhythms. After this first written account there was little activity in investigating this new field until about 25 years ago when interest burgeoned; since then much has been done. Rhythmic physiological processes have been described for all the major groups of plants and animals; and terms such as biological rhythms, biological clocks, and circadian rhythms are well known to biologists and to serious amateur naturalists as well.

This is what the author wishes to write about. To quote from the dust jacket: "Just because the four seasons begin on exact dates on the calendar is no sign that the natural world is bound by any such timetable. Each plant or animal travels at its own speed, finding its food, seeking a mate, unfolding leaves, flinging seed on the wind in perfect timing with an age-old plan." Mr. Rood attempts to weave a discussion of biological rhythms around his observations of plant and animal activity on his 100-acre property in Vermont. He does not manage to accomplish this. What he does do is relate his observations through the seasons (two chapters for each season) with an occasional comment on biological rhythms. This is all fine and good, I suppose, for readers who are being taken through the seasons by a naturalist for the first time. But to the veterans it is all familiar, too familiar. We expected more and did not get it.

There are a number of good points in the book, however. Numerous tidbits of information, of interest to the naturalist, are scattered through its pages. Much of the general biological comment is technically correct and current. Scientific names are given for some (I wonder why he was not consistent and include names for all) of the plant and animal species discussed, and where used they are correct. Readers are made aware of the interrelationships of the natural system; this is an important good point about the book.

Mr. Rood is obviously a knowledgeable naturalist. Yet observations are frequently misinterpreted. For example, "The mantis young must not emerge too soon, for they require living, moving prey. Hence they remain in their nursery until there's an adequate supply of grasshopper nymphs . . . ."; "These residents of the forest understory have to be short-lived, many of them, as the leafy canopy will soon throw the ground into dense shade"; "The goldfinch had to postpone nesting until July or even August when all those seeds were

ready." The author knows how behavior patterns are attained, yet in an attempt to simplify he misleads and confuses. Another oversimplification and inadequate explanation occurs when he describes homiotherapy as "carrying climate in the veins." Other terms, for example 'niche,' are used but not really defined at all.

The author's approach in relating his observations is often anthropomorphic: skunks "yearning" for companionship, female ducks being "bored" with the male courtship display. I found disconcerting the way the subject (plant or animal) being discussed gave way to another and another. Statements on five or six species may occur in one short paragraph so that the reader is left confused. Beginning with chapter 6 there is less of this and the more sustained discussion of a species or a concept is pleasant after so much jumping about earlier.

The author failed to give any consideration to environmental crises or disturbances. These would have fitted into his theme well enough since changes in behavior would result from changes and disturbances in habitat and microhabitat. On two or three occasions the word 'pollution' is used, but it is used almost apologetically. It is as if the author does not wish to introduce this factor into his world, does not wish to complicate his world for himself or for his readers. Do not ignore it Mr. Rood, get involved. You have a responsibility in your reporting.

I wonder how many books of this kind have been published, how many more will be. They mean well, I know that. But unless they say something new, and are relevant to our time, can we have an end soon?

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Models in Paleobiology

Edited by Thomas J. M. Schopf. 1972. Freeman, Cooper Company, San Francisco. 250 pp. $9.40.

Dr. Schopf and his authors have produced a review and synthesis of ten selected major aspects of paleobiology, drawing mainly upon the fossil record of marine invertebrates for their examples. Although Dr. Schopf disclaims (p. 5) that "Those who work on fossil vertebrates or fossil plants have less need for much of what is said [in the book] because their biological background is so much better," I consider that at least 50% of the materials are relevant to general palaeontology and that many palaeontologists of every inclination would probably benefit from reading the chapters, especially those in the latter parts.

The book comprises a series of ten essays grouped into four parts. Part I is the "Introduction" and contains Thomas J. M. Schopf's contribution, "Varieties of Paleobiologic Experience." In these two sections Dr. Schopf draws attention to the need for biological understanding in palaeontology, and that fossils, especially non-vertebrate ones, should not be treated as so many nuts and bolts that have only applied uses, such as stratigraphic markers. He also reviews some of the history of palaeontology and the philosophies that governed or arose from early models or paradigms, and so sets the general tone.

Part II considers "Morphology of the Individual" in two chapters. "Approaches to Morphologic Analysis" by David M. Raup discusses the concept that "all morphology is adaptive" and suggests that some morphologic patterns may derive from adventive sources, although they may subsequently become modified adaptively in divergent lineages. "Approaches to Biogeochemistry" by J. Robert Dodd and Thomas J. M. Schopf considers chemical variation, especially in skeletons, of living organisms and whether such variations are dependent on physical, physicochemical, or genetic factors. While it is apparent that variations in chemical compositions of, say skeletons, exist because of latitudinal variations in oceanic temperatures, it is also evident that animals may discriminate for or against an element on a genetic basis. "How?" or "Why?" this may be done is still relatively unclear. In the fossil record, evidence of such selectivity is often obliterated by subsequent diagenesis.

Part III comprises four chapters on "Populations and Evolution." "Models Involving Population Dynamics" by Anthony Hallam reviews rates of increase and mortality within populations, and the effects of changes in these rates on palaeontological samples deposited or available for collection. "Punctuated Equilibria: An Alternative to Phyletic Gradualism" by Niles Eldredge and Stephen Jay Gould is a consideration of the lacunae in the fossil record. They consider that new species arise at loci on the periphery of the distribution of their ancestors and, because such speciation is geologically rapid, their potential fossil record is curtailed both spatially and temporally. Thus, gaps in the record are 'real' and indicate times of rapid evolutionary change which alternate with times of taxonomic stability to give a picture of "punctuated equilibria." "Models for the Evolution of Planktonic Foraminifera" by Francis G. Stehli, Robert G. Douglas, and Ismail A. Kafescioglu discusses diversity in planktonic foraminifera as a temperature-dependent phenomenon. They consider that greater diversity in the tropics reflects more available riches and show that genera that have a geologically ancient origin are more often present

in colder waters, and vice versa. They therefore conclude that, for planktonic Foraminifera, high rates of speciation or production of new genera are dependent on warmer temperatures. ''Models in Phylogeny'' by Michael T. Ghiselin sets out the *raison d'être* for phylogenetic studies. Dr. Ghiselin considers that such studies must be based on comparative anatomy, and that ''we are interested mainly in the order of, and relations between, the parts'' and ''do not merely count similarities.'' He stresses the parsimonious interpretation of observations and the application of the spatial distribution of the fossils as well as their stratigraphic record. Thus, a phylogeny is an interpretative device in which much evidence from various sources and many judgments on the importance of characters are made. In the palaeontological record, absence of specimens, i.e., negative evidence, is rejected, except under extreme caution.

Part IV comprises three chapters on ''Distribution.'' ''Conceptual Models of Benthic Marine Communities'' by Ralph Gordon Johnson discusses why particular species are found where they are, both in the present and in the fossil record. He records that fewer species are present in areas in which the substrate has been recently disturbed and suggests that the facies or conditions of deposition of the matrix may indicate whether a palaeontologic sample may be less than representative of the original living community. ''Models in Biogeography'' by Daniel Simberloff discusses mathematical concepts for ecological events in isolated ecosystems. The factors of rates of immigration, extinction and speciation, the relative sizes of the land masses of origin and colonization, and the distances involved are all related mathematically. Because the balances between rates of extinction and immigration or speciation differ under various conditions of the land mass, the fossil samples available will vary in diversity, and this must affect their biological interpretation. ''Conceptual Models of Ecosystem Evolution'' by James W. Valentine relates the strategies by which organisms may react to stable or fluctuating energy systems. He considers that extinction in a highly varied and stable ecosystem comes about with increasing fluctuation in the energy source which will favor the adaptable ecological generalist at the expense of the specialist, and thus the diversity of the systems will decrease.

These ten essays do succeed in their authors' wishes to introduce to others wider concepts by which invertebrate palaeontologists may see their science more clearly. The volume also contains all the references cited in full for easy location, an attribute with which I am fully in accord, as many an abbreviated reference has remained unlocated by me because of too cryptic a citation or an error that is not evident. There is also an index containing all proper names and many subject headings.

I do not recommend this book for general or easy reading, but do recommend it to palaeontologists or ecologists. Certainly those interested in the marine ecology and palaeontology will benefit from its contributions.

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NEW TITLES

Zoology

***Alaska and its wildlife.** By B. L. Sage. 1973. Viking Press, New York. 128 pp. $14.

The animal in its world. Explorations of an ethologist 1932–1972. Volume 2, Laboratory experiments and general papers. By N. Tinbergen. 1973. Harvard University Press, Cambridge, Mass. 232 pp. $14.

Animal parasites. Their life cycles and ecology. By O. W. Olsen. 1974. 3rd edition. University Park Press, Baltimore. 525 pp. $16.50.

***Atlas of animal migration.** By C. Jarman. 1972. John Day, New York. 124 pp. $10.95.

★***Bird damage to fruit crops in the Niagara Peninsula.** By R. G. B. Brown. 1974. Canadian Wildlife Service Report Series Number 27. 60 pp. $1.50.

★***Butterflies of Saskatchewan.** A field guide. By R. R. Hooper. 1973. Saskatchewan Department of Natural Resources. Copies available from the Museum of Natural History, Regina, P.O. Box 1121. 216 pp. $3.

***Butterflies of the world.** By H. L. Lewis. 1973. Harrap, London. 312 pp. $37.

★***Calf mortality on the calving ground of Kaminuriak caribou.** By F. L. Miller and E. Broughton. 1974. Canadian Wildlife Service Report Series Number 26. 26 pp. $1.

★***Canadian wildlife and man.** By A. I. Dagg. 1974. McClelland and Stewart, Toronto. 192 pp. $10.

Care of the wild feathered and furred. A guide to wildlife handling and care. By M. Hickman and M. Guy. 1974. Unity Press, Santa Cruz, California. 144 pp. Cloth $7.95; paper, $3.95.

Chameleons and other quick-change artists. By H. Simon. 1973. Dodd, Mead, New York. 158 pp. $7.95.

Crustaceans. By W. L. Schmitt. 1973. David and Charles, Devon, England. £3.50.

Dancers on the beach. The story of the grunion. By E. R. Ricciuti. 1973. Crowell, New York. 56 pp. $3.95.

★***Domestication of the carp *Cyprinus carpio* L.** By E. K. Balon. 1974. Royal Ontario Museum Life Sciences Miscellaneous Publication. 38 pp. $3.

Effects of DDT on man and other mammals, I. Papers by T. Jukes, H. R. Wolfe, D. P. Morgan, et al. 1973. MSS Information Corp., New York. 164 pp. $15.

Effects of DDT on man and other mammals, II. Papers by G. L. Henderson, S. M. Sieber, W. L. Heinrichs et al. 1973. MSS Information Corp., New York. 180 pp. $15.

Eyelids of morning. The mingled destinies of crocodiles and men. 1974. By A. Graham. New York Graphic Society, Greenwich, Conn. 260 pp. $22.50.

★***Feeding ecology of pintail, gadwall, American widgeon and lesser scaup ducklings.** By L. G. Sugden. 1973. Canadian Wildlife Service Report Series Number 24. 46 pp. $1.50.

***Fisheries of the North Pacific.** By R. J. Browning. 1974. Alaska Northwest Publishing Co., Anchorage, Alaska. 408 pp. $24.95.

★***A guide to the freshwater sport fishes of Canada.** By D. E. McAllister and E. J. Crossman. 1974. National Museums of Canada, Marketing Services Division, 360 Lisgar, Ottawa K1A 0M8. 107 pp. $3.75. French edition also available.

★***Home range and breeding biology of the shoveler.** By H. J. Poston. 1974. Canadian Wildlife Service Report Series Number 25. 50 pp. $1.50.

***Human behavior aspects of fish and wildlife conservation.** An annotated bibliography. By D. R. Potter, K. M. Sharpe, and J. C. Hendee. 1973. Pacific Northwest Forest and Range Experimental Station, P.O. Box 3141, Portland, Oregon. 288 pp.

Killers of the seas. By E. R. Ricciuti. 1973. Walker, New York. 308 pp. $10.

★***Mammals of Ontario.** By A. I. Dagg. 1974. Otter Press, Box 747, Waterloo, Ontario. 160 pp. $10.25 hard cover; $6.75 paper cover.

Man and his foods. Studies in the ethnobotany of nutrition — contemporary, primitive, and prehistoric non-European diets. Papers from a congress held at Seattle, Washington, in August 1969. C. E. Smith, Jr. (Editor). 1973. University of Alabama Press, University. 132 pp. $6.50.

★***Migration of Lesser Snow and Blue Geese in spring across southern Manitoba.** Part 1. By H. Blokpoel. 1974. Canadian Wildlife Service Report Series Number 28. 30 pp. $1.

Parrots of the world. By J. Forshaw. 1973. David and Charles, Devon, England. £35.

Responses of fish to environmental changes. W. Chavin (Editor). 1973. Thomas, Springfield, Ill. 460 pp. $19.75.

The salmon. Their fight for survival. By A. Netboy. 1974. Houghton Mifflin, Boston. 614 pp. $15.

Schooling in the ecology of fish. By D. V. Radokov. Translated from the Russian. 1973. Halsted (Wiley), New York. 174 pp. $19.75.

A study of bird songs. By A. Armstrong. Musson, Toronto. 343 pp. $4.75.

Summer of a million wings. By H. Brandon-Cox. 1974. David and Charles, Devon, England. £3.25.

The vanishing harvest. By K. Johnstone. 1973. Musson, Toronto. 88 pp. $1.95.

Viruses and invertebrates. A. J. Gibbs (Editor). 1973. North-Holland, Amsterdam, and Elsevier, New York. 674 pp. $60.

The wasps. By H. E. Evans and M. J. West Eberhard. 1973. David and Charles, Devon, England. £3.75.

The whale problem. A status report. W. E. Schevill (Editor). 1973. Harvard University Press, Cambridge, Mass. $12.50.

Wildlife heritage of South Africa. By D. Hey. 1973. Oxford University Press, London. 246 pp.

Botany

★**Chemotaxonomy of flowering plants.** By R. D. Gibbs. June 1974. McGill-Queen's University Press, Montreal. Four volumes of about 2500 pp. $135, or $110 before publication.

A dictionary of the flowering plants and ferns. By J. C. Willis. 1973. Revised by H. K. Airy Shaw. 8th edition. Cambridge University Press, New York. 246 pp. $32.50.

The ecological role of fire in natural conifer forests of western and northern North America. H. E. Wright and M. L. Heinselman (Editors). 1973. Papers from a symposium held at the University of Minnesota in August 1972. Academic Press, New York. $9.50.

The families of flowering plants. By J. Hutchinson. 1973. 3rd edition. Clarendon (Oxford University Press), New York. 968 pp. $62.50.

A flora of the White Mountains, California and Nevada. By R. M. Lloyd and R. S. Mitchell. 1973. University of California Press, Berkeley. 202 pp.

Flowers of south-west Europe. A field guide. By O. Polunin and B. E. Smythies. 1973. Oxford University Press, London. 480 pp.

★**Freshwater algae of Ellesmere Island, N.W.T.** By H. Croasdale. 1973. National Museums of Canada, National Museum of Natural Science, Publications in Botany Number 3. 131 pp.

The fungi. An advanced treatise. Volume 4, Part B, A taxonomic review with keys. Basidiomycetes and lower fungi. G. C. Ainsworth, F. K. Sparrow, and A. S. Sussman (Editors). 1973. Academic Press, New York. 504 pp. $28.

A guide to air quality monitoring with lichens. By W. C. Denison. 1973. Lichen Technology, Corvallis, Oregon. 40 pp. Paper, $3.

A guide to the medicinal plants of the United States. By A. and C. Krochmal. 1973. Quadrangle, New York. 260 pp. $9.95.

Handbook of vegetation science. Part 5, Ordination and classification of communities. R. H. Whittaker (Editor). 1973. Dr. W. Junk, The Hague. 738 pp. Dfl. 160.

Human poisoning from native and cultivated plants. By J. W. Hardin and J. M. Arena. 1974. 2nd edition. Duke University Press, Durham, N.C. 194 pp. $6.75.

Identify trees and shrubs by their leaves. By E. Knobel. 1973. Musson, Toronto. 47 pp. $1.50. A republication of the original 1894 edition revised by Prof. E. S. Harrar.

***Mushrooms of North America.** By O. K. Miller, Jr. 1972. Dutton, New York. 360 pp. $20.75.

★**Plants of the south west part of Thunder Bay District.** By W. Hartley, RR 4, Thunder Bay F, Ontario P7C 4Z2. 1974. 96 pp. $1.50. An annotated list of 789 species, giving localities, collectors and dates of collection. Enlarged by over 800 entries, including 150 new records, from a previous list.

Quantitative and dynamic plant ecology. By K. L. Kershaw. 1974. 2nd edition. American Elsevier/North-Hollánd Publishing Co., New York. c304 pp. $16.50.

***Research experiences in plant physiology.** A laboratory manual. By T. C. Moore. 1974. Springer-Verlag, New York. 462 pp. $9.50.

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Mailing date of previous issue 30 August, 1974

We regret that publication dates of recent issues of *The Canadian Field-Naturalist* have been late because of problems and delays at the printers. We further regret that in some copies of the journal pages 183–196 were of an unacceptable quality.

Erratum: The correct scientific name of the collared lemming on the cover of Volume 88(2) is *Dicrostonyx groenlandicus richardsoni*.

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Cover photograph:

Bald Eagle at nest, from north shore of Lake Superior (1947), by R. Dalton Muir.

The Canadian Field-Naturalist

VOLUME 88 OCTOBER-DECEMBER, 1974 NUMBER 4

Bald Eagle Nesting Habitat, Density, and Reproduction in Central Saskatchewan and Manitoba

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Whitfield, D. W. A., J. M. Gerrard, W. J. Maher, and D. W. Davis. 1974. Bald Eagle nesting habitat, density, and reproduction in central Saskatchewan and Manitoba. Canadian Field-Naturalist 88: 399–407.

Abstract. A Bald Eagle (*Haliaeetus leucocephalus*) population breeding in the boreal forest region of central Saskatchewan and Manitoba is described. The primary nesting habitat of these eagles is a narrow strip, about 200 yards wide along the shores of the major lakes and rivers. Aerial surveys in 1969 covering 14 subregions of the study area showed that there were 0.083 ±0.030 breeding areas per mile of primary habitat searched. We estimated the total population of the Saskatchewan part of the study area to be 1592–7970 at midsummer. It is likely that these eagles contribute significantly to the wintering population in the midwestern United States. The productivity of the population appears to be sufficient for maintenance at the existing level.

Introduction

Large numbers of Bald Eagles winter in the United States (Sprunt 1961). They breed in Michigan (Sprunt et al. 1973), Wisconsin (Sprunt and Ligas 1964), Minnesota (Mathison 1969) and northwestern Ontario (Grier 1969), but the populations in these regions do not seem to be large enough to account for all the eagles seen in the midwestern United States in winter. This paper describes a large breeding population of the species in Saskatchewan and Manitoba. We made our first observations on these eagles in 1967 (Gerrard and Whitfield 1967). The present report, based on more extensive surveys in 1968 and 1969, discusses the nesting habitat, density, size, and productivity of this population.

Study Area

The study area (Figure 1) is in the boreal forest region of central Saskatchewan and Manitoba. This approximately 95,000-square-mile area of low forested hills and numerous lakes and rivers is largely underlain by the Precambrian Shield. Water drainage is to Hudson Bay through the Churchill and Saskatchewan Rivers. Predominant trees include white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), black spruce (*Picea mariana*), jack pine (*Pinus banksiana*), and balsam fir (*Abies balsamea*).

There are few roads into this region and most of it is sparsely inhabited. Major human uses include trapping, commercial and sport fishing, big game hunting, mining, and pulp-cutting.

Methods

General

Surveys were done in May 1969 during early incubation and in July 1968 and 1969 when the young eagles were from 4 to 10 weeks old. We located eagle nests by searching along the shores of lakes and rivers, using either fixed-wing pontoon-equipped aircraft or boats (the latter for less than 10% of the survey). When flying, usually at a height of 50 to 300 feet, we followed what we judged to be promising routes, based on information from local inhabitants, or on previous visits to the area. No attempt was made to follow a grid pattern. Our flight course did, however, necessitate frequent flights over forested areas between lakes. These were also searched carefully. Each nest we found was marked on a map of scale 1:250,000. Length of

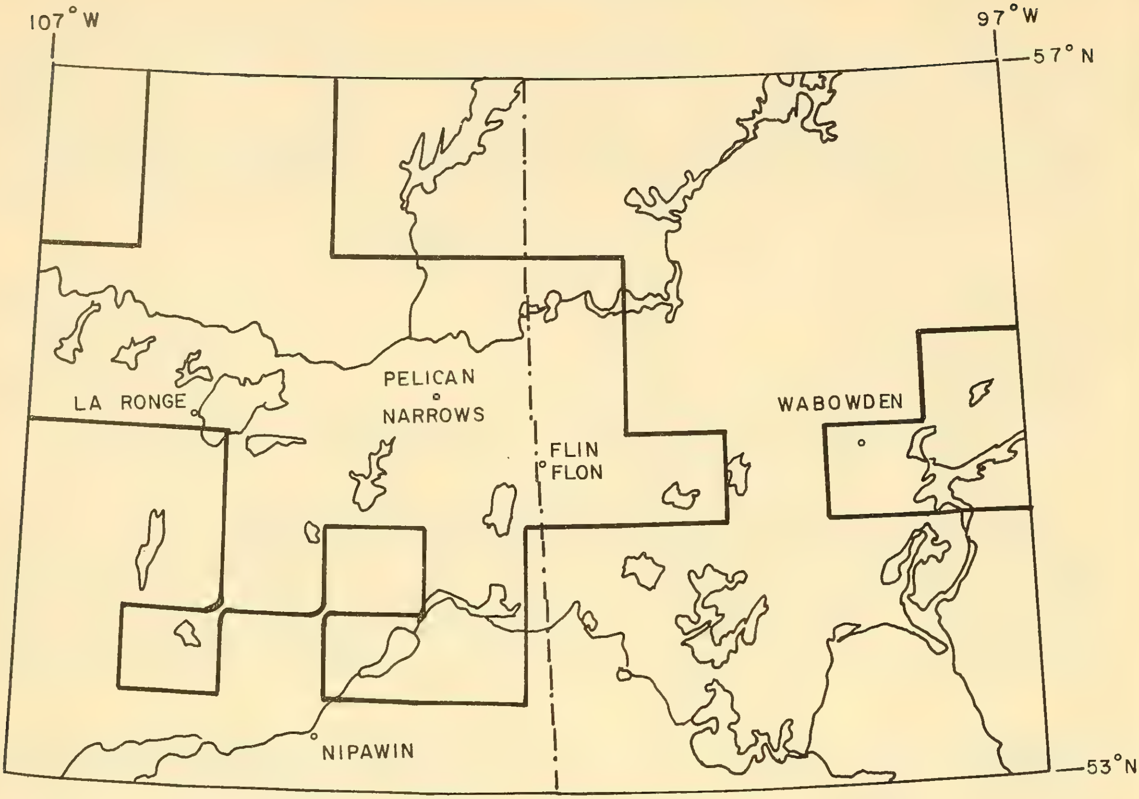

FIGURE 1. An outline map on which the areas surveyed are enclosed in heavy lines. Not all shoreline within these areas was searched. The vertical dot-dash line is the boundary between Manitoba (on the right) and Saskatchewan. The towns indicated are those from which the aerial surveys were flown.

shoreline was measured on these maps using a map measurer with a 1/4-inch wheel. Density of breeding areas was expressed as number per mile of shoreline along major rivers and those lakes with a shoreline length greater than 7 miles. While this measure of density provides a reasonable basis for assessing the Bald Eagle population and providing regional comparisons, it must not be taken as absolutely correct because the length of shoreline is hard to determine accurately.

Terminology

Terminology used is that of Postupalsky (1973) and of L. Brown (personal communication) with minor modifications. Much of this uses the concept of a Bald Eagle breeding area – an area occupied by a pair of Bald Eagles at the time of the survey or at some recent time, and containing one or more nests. For the purpose of this survey one or more Bald Eagle nests, whether empty or active, within a circle of 1/2-mile diameter was considered to represent one breeding area. While we realize that nests farther apart than this may on occasion be within the same breeding area, this criterion provides a workable approach to surveys in this region and is generally consistent with our detailed studies over a period of several years at Besnard Lake, Saskatchewan. Breeding areas where incubation began in the spring (indicated by an incubating adult, eggshell fragments, or young later in the season) were considered active. Active breeding areas and those with two adults or signs of use (fresh branches or a nest cup) were considered occupied. Nests which had young four or more weeks old were considered successful. Birds not in nests, but in pre-adult plumage were called subadult. As surveys were conducted prior to fledging, none of those called subadult in this report were birds of the year.

By the expression "primary nesting habitat" we mean a strip of land within 200 yards of rivers and of those lakes having a total shoreline of more than 7 miles.

Results

We found 82 Bald Eagle nests with young in 129 breeding areas in 1968 and 137 nests with young in 245 breeding areas in July 1969. Twenty-eight breeding areas, 19 of them with young, were in Manitoba and the remainder were in Saskatchewan. Tables 1 and 2 summarize some of the data from the surveys.

TABLE 1 — Results of surveys in 1968 and 1969

	1968	1969	
Survey date	July 1–19	May 3–4 July 12–15	June 30– July 20
Number of breeding areas	129	64	245
Number of occupied breeding areas		53–55	
Number of active breeding areas		51	
Number of successful breeding areas	82	36	137
Number of young	132–139	63–68	228–240

TABLE 2 — Reproductive indices of the Saskatchewan and Manitoba Bald Eagle population

Survey	July 1968	May + July* 1969	July† 1969
Breeding areas occupied	—	83–86%	—
Breeding areas active	—	80%	—
Breeding areas successful	64%	56%	56%
Occupied breeding areas which were successful	—	65–68%	
Active breeding areas which were successful	—	71%	
Number of young per successful nest	1.6–1.7	1.7–1.9	1.7–1.8
Number of young per active nest	—	1.24–1.35	
Number of young per occupied breeding area	—	1.15–1.26	
Number of young per breeding area	1.02–1.08	0.98–1.07	0.93–1.0

*Those breeding areas observed in both May and July 1969.
†All breeding areas which were checked in July.

Nesting Habitat

Sixty-eight percent of nests found were within 50 yards of a lake or river and 90% were within 200 yards (Figure 2). Only two nests were found along 264 miles of flight routes which were more than 800 yards from a lake or river. Only nine nests were found in 342 miles of shoreline searched on lakes with a shoreline of 7 miles or less.

Population Density and Size

The regional distribution of breeding areas seen in 1969 is shown in Figure 3. Since the Bald Eagles of this region usually choose their nest sites along the shores of the larger lakes and rivers, we calculated the number of breeding areas per mile of primary nesting habitat searched by aircraft for each region (Figure 4). There was a regional variation from 0.04 to 0.14 breeding areas per mile (mean 0.083, standard deviation 0.030.)

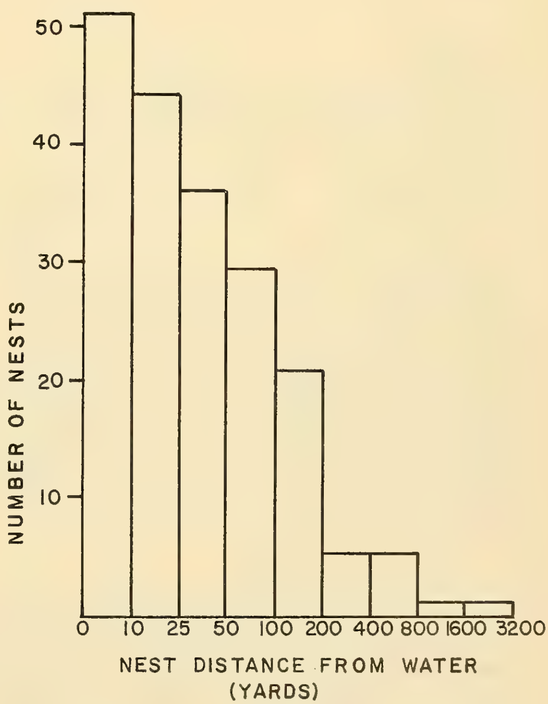

FIGURE 2. A histogram presentation of nest distance from the waters' edge.

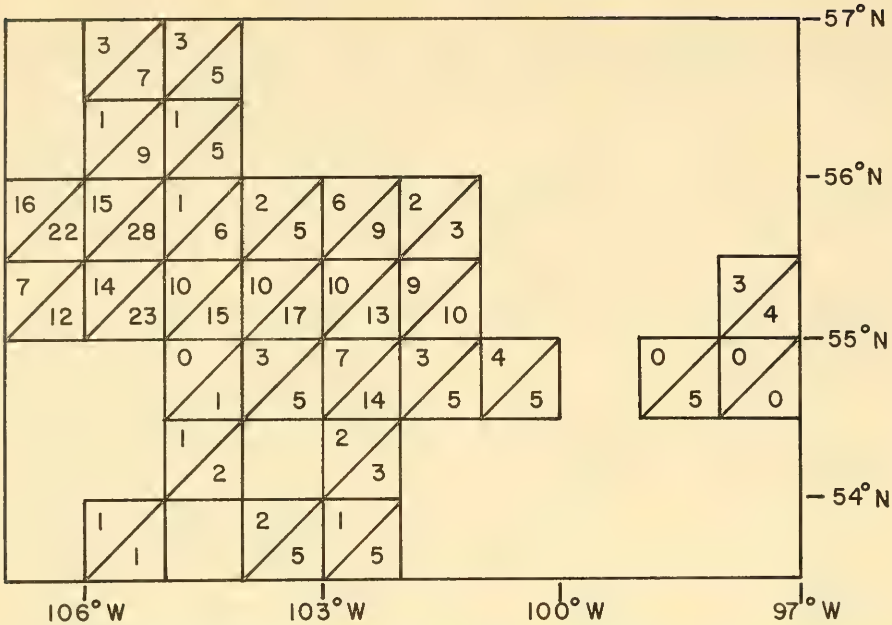

FIGURE 3. The regional distribution of the total numbers of breeding areas (below the slashes) and successful breeding areas, in July 1969. The regions have a dimension of 1/2 degree latitude by 1 degree longitude.

Productivity

In 1968, 64% of 129 breeding areas were successful compared to 56% of 245 in 1969. The differences between 1968 and 1969 are not statistically significant.

We found 1.6–1.7 young per nest with young in July 1968, and 1.7–1.8 young per nest with young in July 1969.

Eighty-three to eighty-six percent (53–55 of 64) of breeding areas examined in May 1969 were occupied. The uncertainty is due to two empty nests with only one adult nearby. Thirty-six (65–68%) of these nests contained young 6–10 weeks old in July. There were 1.15–1.26 young produced per occupied breeding area. The distribution of the number of young per nest with young is given in Figure 5.

Nest Failures

Eleven (22%) of the 51 nests active in May were standing but empty in July, and four were gone. The causes of the failures are unknown, but two further observations are suggestive. First, the usual reaction of the incubating adult as we flew by the nests in May was to sit tight on the eggs. In seven cases the incubating adult stood up or flew from the nest; of these, one was gone, four had failed, and only two were still active by July. The difference between this group of nests and the remainder of those seen in May is significant with $\chi^2 = 10.5$, 1 df, and $P<0.01$. Second, there was a statistically significant tendancy for breeding areas empty in July 1968 and active in May 1969 to fail before July (Table 3, $\chi^2 = 6.43$, 1 df, $P < 0.01$).

TABLE 3 — Status, in July 1969, of those breeding areas visited in 1968 and active in May 1969

	Status in July 1969	
	Empty	Active
Empty in 1968	6 (60%)	4 (40%)
Active in 1968	3 (14%)	18 (86%)

Population Age Structure

Sixteen (16%) of 101 Bald Eagles seen in May and 50 (16%) of 307 seen in July (excluding nestlings) were subadults. When the nestling

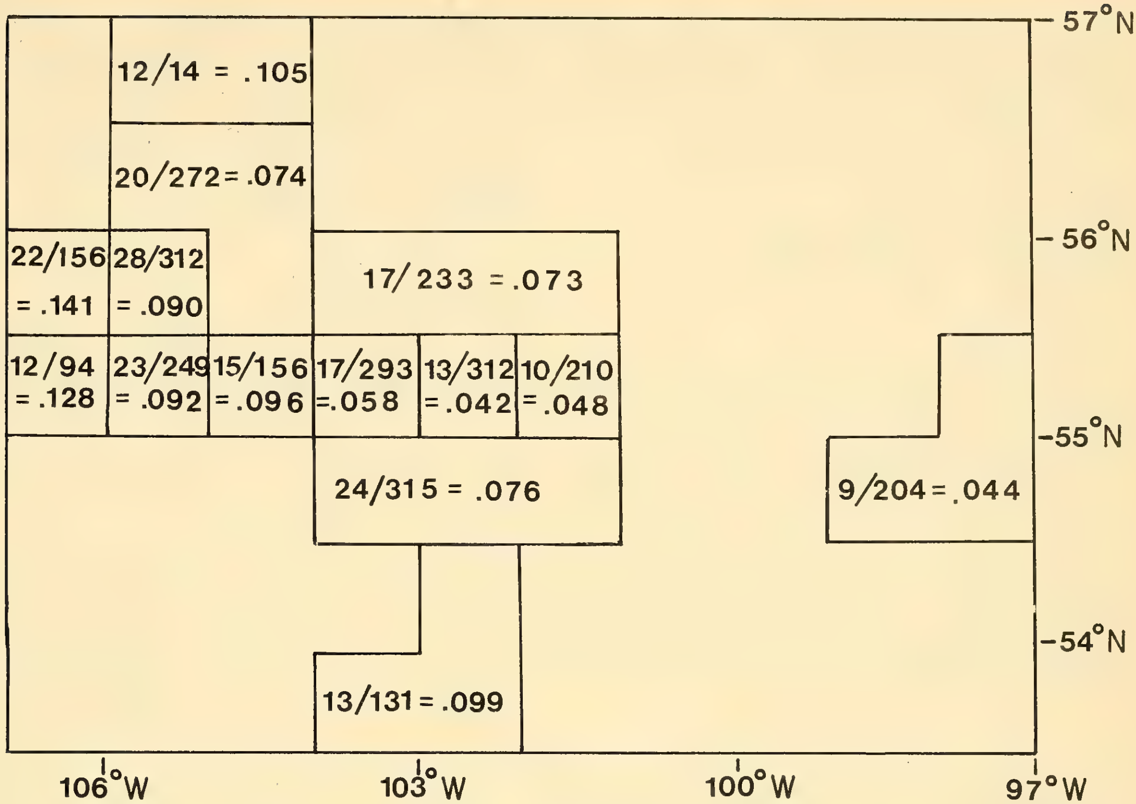

FIGURE 4. Regional variation in shoreline utilization in 1969. The numerators are number of breeding areas censused by aircraft; the denominators are the miles of aircraft-searched shoreline. Grouping of some areas was done to increase sample size.

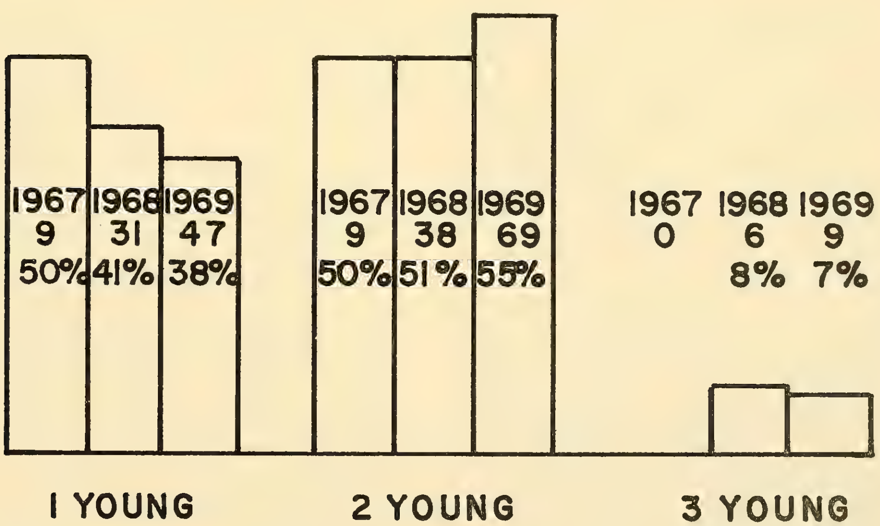

FIGURE 5. The number and percentage of nests with one, two, and three young in 1967, 1968, and 1969. Only nests for which the numbers of young were definitely ascertained contribute to this figure.

eagles were added to the subadult population, 52–54% (278–290 of 535) of the eagles seen were preadult. In one locality 12 subadults and 22 adults not at nests (an unusually high proportion) were seen in about 90 miles of flying.

History of Nest Uses

Tables 4 and 5 summarize our data on breeding area history from 1967 to 1969.

Discussion

Nesting Habitat

In this area, eagles nest primarily in a narrow band of shoreline habitat within 200 yards of larger lakes and major rivers. Shoreline provides fishing and loafing perches, nest trees, and flight paths on updrafts, and thus may be optimum habitat in an area which is sparsely inhabited. In proportion to miles searched, few nests were found elsewhere. Indeed, of nine nests on smaller lakes and rivers, eight were within 2 miles of a larger lake. In marked contrast to this region is the Bena District of the Chippewa National Forest of northern Minnesota where only eight of 25 nests were within 1/4 mile of open water and nine nests were farther than 1/2 mile from open water (Juenemann 1973). Increased human presence along the lakes and rivers of the Chippewa Region may have resulted in eagles choosing nest sites farther from open water, although there may be other factors involved as well.

Population Density and Size

The data presented above enable us to make detailed estimates of the Saskatchewan Bald Eagle population, and roughly extend the result to Manitoba. We first determine the extent of primary nesting habitat, multiply by the density of active breeding areas in that habitat, and finally multiply by the total number of individuals of all age classes per active breeding area.

The lower and upper 95% confidence limits on the number of breeding areas per mile of shoreline searched were .066 and .100. Assuming the 2510 miles of shoreline we searched to be representative of the measured 17,290 miles of

TABLE 4 — Status of breeding areas in 1968 and July 1969 according to their status in 1967

a — P 1967

1968 \ July 1969	G	NC	E	B	NB
NB	0	0	1	0	2
B	0	0	1	3	2
E	2	0	2	0	1
G	0	3	0	0	2

b — E 1967

1968 \ July 1969	G	NC	E	B	NB
NB	0	0	0	0	0
B	1	0	1	1	0
E	0	0	2	1	2
G	0	0	0	0	0

c — U 1967

1968 \ July 1969	G	NC	E	B	NB
U	X	X	58	23	54
NB	5	4	12	8	14
B	0	0	11	5	11
E	6	5	20	4	4
G	X	X	X	X	X

d — Totals

1968 \ July 1969	B	NC	E	B	NB
U	X	X	58	23	54
NB	5	4	13	8	16
B	1	0	13	9	13
E	8	5	24	5	7
G	0	3	0	0	2

SYMBOL DEFINITIONS:

NB, breeding area produced young which were not banded
B, breeding area produced young which were banded
P, breeding area produced young
E, breeding area contained only empty nests
NC, breeding area was not checked
G, all of the nests in the breeding area were gone
U, the breeding area was unknown
X, a logically impossible category

TABLE 5 — Status of breeding areas in May 1969 and July 1969 according to their status in 1968

a — E 1968

May 1969 \ July 1969	G	NC	E	B	NB
A	1	0	6	1	3
E	0	3	0	X	X
G	0	1	0	0	0

b — NB 1968

May 1969 \ July 1969	G	NC	E	B	NB
A	0	0	2	3	7
E	0	2	0	X	X
G	0	2	0	0	0

c — B 1968

May 1969 \ July 1969	G	NC	E	B	NB
A	1	0	1	1	7
E	0	3	1	X	X
G	0	0	0	0	0

d — U 1968

May 1969 \ July 1969	G	NC	E	B	NB
A	2	0	2	4	10
E	0	4	0	X	X

e — Totals

May 1969 \ July 1969	G	NC	E	B	NB
A	4	0	11	9	27
E	0	12	1	X	X
G	0	3	0	0	0

SYMBOL DEFINITIONS:
A, adult sitting on nest and apparently incubating eggs
Remainder of symbols as in Table 4.

shoreline in our study area west of 102°W longitude, we estimate 1141 to 1729 breeding areas in that region. But as our searching was not random and we often left out parts of lakes where eagle habitat was subjectively poor, a second, more conservative estimate was made by considering the breeding areas we found to represent 6974 miles of shoreline, which was the total for all lakes even partly searched. This gives 460 to 697 breeding areas.

Eighty percent of these breeding areas were active (Table 2). To the two adults per nest thus counted we must add the number of adults which do not start incubation. Twenty-three percent of adults seen in May 1969 were not at active nests. This is only a crude estimate of the proportion of non-breeders because (1) breeding adults may wander widely during incubation (Gerrard, J. M. and P. N. Gerrard, unpublished observations); (2) late migrants which are moving on to breeding areas further north may be present during early surveys; (3) some non-breeding adults may occupy breeding areas; (4) some adults seen at empty nests may not have begun incubation or may already have suffered nesting failure; and (5) we may have missed seeing many of the adults in the area. Thus, each adult at an active nest represents about 1.30 adults altogether.

Computing the proportion of subadults is also difficult. They are harder to see and tend to complete spring migration later than adults (Southern 1964). Our finding that 16% of the eagles seen in 1969 were subadults is probably an underestimate of the actual situation. Studies on Besnard Lake (near La Ronge, Saskatchewan) in late May and June in 1970 suggest that the subadults may have made up as much as 41% of the population (Buckle, D. J., J. M. Gerrard, P. Gerrard, W. J. Maher, P. N. Oberholtzer, J. Stilborn, and D. W. A. Whitfield. 1970. Bald Eagle behaviour study 1970. Part I. Unpublished report). We take each adult as representing 1.19 to 1.70 subadults.

From Table 2, we take each breeding area as producing .98 to 1.07 young.

Then, assuming no mortality of adults or immatures between early May and August, each breeding area would represent a minimum of $.8\times(2\times 1.3 \times 1.19) + .98 = 3.46$ to a maximum of $.8\times(2 \times 1.30 \times 1.70) + 1.07 = 4.61$ eagles at

fledging. Multiplying by the number of breeding areas calculated above yields 1592 to 7970 birds at fledging in the study area west of 102°W. This area is very roughly a fifth of the total boreal forest area in Manitoba and Saskatchewan. Thus, if these birds migrate to the midwestern United States as our banding results indicate (Whitfield, D. W. A. and J. M. Gerrard, unpublished observations), they must make up a large proportion of the eagles wintering in that region.

Productivity

Aiming as we are towards a quantitative understanding of Bald Eagle population dynamics in our study area, we should measure the real reproductive rate of the population, that is, the number of young produced divided by half the number of resident adults (Brown 1973). The following is a discussion of our attempts to do this, and of several reproductive indices which we think are useful for comparison of productivity between populations.

First, we may simply divide the total number of young produced in nests which were surveyed in May 1969 by half the number of adults seen on that survey (63–68 of 85–86 = 1.47 to 1.60). This exceeds even the number of young produced per active nest (Table 2), and thus is obviously much higher than the real reproductive rate. The reason is easily found: the total number of adults seen on that survey was not even twice the number of incubating adults. Obviously, we failed to see a large fraction of all the adults resident in the surveyed area. This could be caused by their flying inland where we didn't search, or by our simple failure to pick them out as we flew the survey. Whatever the reason, we must use a more indirect approach to estimate real productivity.

A second index, the number of young produced per breeding area (Table 2) is easily measured, probably a bit biased because we more easily find occupied than unoccupied nests, and is likely close to the real productivity. The latter point follows from the observed high turnover rate of breeding areas; 11.5% of the breeding areas seen in 1968 had no nests left by 1969. This appears to result from the relatively small size of the trees in which the nests are built, and means that the number of breeding areas is unlikely to exceed by much the number of adult pairs, assuming that we are correctly identifying breeding areas, and that the adults do not generally change breeding areas from year to year. Thus, this index is our best estimate of the real productivity.

Next we consider the young produced per occupied breeding area. Sprunt et al. (1973), using a terminological scheme in which our "occupied breeding area" is equivalent to their "active territory," assert the importance of this index and use it to make comparisons among six Bald Eagle populations. They conclude that in populations which are judged from other information to be stable, the minimum number of young per active territory is 0.7 and the extreme high they observed was 1.2. Our result of 1.15 to 1.26 young per occupied breeding area indicates a stable population. But we feel that the accurate determination of the number of occupied breeding areas is very difficult, since occupying adults which do not have eggs or young may not be found in the vicinity of their nests, and since "floating" adults, or adults passing through on migration, may at times be found in the vicinity of unoccupied nests. Our obvious failure to find a large fraction of all the adults present during the May survey strengthens our distrust of this index, and we treat our measurement of it, and of the proportion of occupied breeding areas which were successful (65–68%) as only rough estimates of reality.

Lastly, we have determined the number of young produced per active breeding area, the proportion of active breeding areas successful in raising young, and the number of young per successful nest. Since, once the eagles have begun incubation they are off the nest for less than 2% of the time, and even when they are off, remain in the vicinity (Gerrard, J. M. and P. N. Gerrard, unpublished observations), we regard these indices as accurate, reproducible, and largely independent of interpretation and of the observer's abilities, and thus as most useful for year-to-year and area-to-area comparisons.

Nest Failures

We feel that the flight of some adults from their nests when we flew by on the May survey did not reflect the degree of our disturbance, which was not greater at these nests than at others, but rather indicated the lack of attachment of the adults to the nests, which in turn influenced nest success.

The fact that nests that were empty in July 1968 and active in May 1969 were more likely to fail than nests that had had young in July 1968 may reflect a pattern of behavior in the adults, poor position of nest sites, inexperienced adults, or the effects of human disturbance or environmental contaminants.

Acknowledgments

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James W. Grier helped with parts of the survey and provided many suggestions that improved the quality of the work. R. Sanderson, G. Michalenko, J. Jessberger, and Dr. and Mrs. B. R. Heal helped as observers.

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Annual Cycle of Activity and Weight Changes in Richardson's Ground Squirrel, *Spermophilus richardsonii*

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Michener, D. R. 1974. Annual cycle of activity and weight changes in Richardson's ground squirrel, *Spermophilus richardsonii*. Canadian Field-Naturalist 88: 409–413.

Abstract. Data were gathered on annual activity cycle, lactation, growth, and weight changes in a population of Richardson's ground squirrels in southern Saskatchewan. Adult males emerged from hibernation in late March and females emerged in early April. Adult males entered hibernation in early July, followed by adult females in late July. Young emerged from the nest burrow in the last week of May and early June. By mid-August young constituted 100% of the active population. Young males entered hibernation later than young females. All age classes of adult females reproduced, with 92–100% lactation each year of the study. Yearling females emerged from hibernation significantly lighter than older females. Some data suggests that heavier animals in the adult male, young male, and young female classes are more likely to be found on the study area following hibernation than lighter ones. Adult and young males were consistently heavier than adult and young females respectively.

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Introduction

Typically, breeding and establishment of territories occur shortly after ground squirrels emerge from hibernation. Birth occurs approximately a month later, and a month after that the young are sufficiently developed to begin above-ground activities. Growth is rapid in young; and adults and young fatten prior to hibernation in late summer. Young enter hibernation later than adults. This general pattern exists for *Spermophilus beechyi* (Fitch 1948), *S. leucurus* (Bradley 1967), *S. richardsonii* (Clark 1970; Michener 1968; Yeaton 1969, 1972), *S. tridecemlineatus* (McCarley 1966; Rongstad 1965), and *S. undulatus* (Mayer 1953; Carl 1971). Reproduction has been investigated in several species of *Spermophilus*. All females, except young of the year, were reported to be pregnant following the breeding season of *S. lateralis* (Tevis 1955), *S. richardsonii* (Nellis 1969; Sheppard 1972), and *S. undulatus* (Carl 1971). Data on growth and weight changes in ground squirrels have been collected by several investigators. Skryja and Clark (1970) reported that body weights of *S. lateralis* decreased in adult males after spring emergence and then increased as hibernation approached. Adult females gained weight continuously from the time of emergence until entering hibernation. Adult *S. richardsonii* gain weight from the time they emerge from hibernation in March until July (Clark 1970), and adult *S. tridecemlineatus* also gain between emergence in April and hibernation in August (Hohn and Marshall 1966).

In the summers of 1969, 1970, and 1971 data on annual cycles of activity, reproduction, growth, and weight changes were collected on a population of Richardson's ground squirrels, *Spermophilus richardsonii*, in southern Saskatchewan as part of a study of population dynamics (Michener 1972).

Methods

The study area was a 168-hectare tract of the Key West Community Pasture near Kayville, Saskatchewan (49°41′ N, 105°13′ W), 130 kilometers southwest of Regina. A description of the area appeared elsewhere (Michener 1972).

Ground squirrels were trapped from 22 April to 28 August 1969, 5 April to 9 September 1970, and 5 April to 13 October 1971. Field work prior to 5 April was impracticable because of bad weather and low numbers of animals. The study area was divided into seven trapping sectors. Each sector was intensively trapped in turn for about 3 days. An attempt was made to catch all squirrels which were seen in a sector each time that area was trapped (approximately four times each summer). When a squirrel was observed it was chased into a burrow; four traps (National Live traps, 16×16×48 centimeters) were arranged about the burrow entrance, and surrounding burrows were blocked with earth to prevent escape. It was estimated that 70% of the attempted captures were successful.

When a ground squirrel was caught it was weighed to the nearest 5 grams on a spring scale, sexed, classified as adult or young of the year on the basis of size, and marked with a numbered ear tag (National Band and Tag Company) in each ear. Females with enlarged mammae or patches of dark or matted fur around the mammae were classified as lactating. After processing, the ground squirrel was released into the burrow from which it had come and the traps were removed.

Results and Discussion

Annual Activity Cycle

Each trapping season was divided into weekly periods with week 1 beginning on 1 April. Figure 1 shows the proportions of the total weekly catch, including recaptures, by age and sex. In the first week of April adult males made up the majority of the population, suggesting that males emerge earlier from hibernation than females. The proportion of females increased rapidly as they emerged from hibernation. During the first half of July the proportion of adult males decreased to nearly zero. It is assumed that the males were entering hibernation, not dispersing, because individuals were recaptured in the subsequent summer at the original locations. The adult female proportion approached zero by the end of July when females entered hibernation.

In 1969 the first young ground squirrel was trapped on 26 May, in 1970 on 31 May, and in 1971 on 4 June. G. R. Michener (1973) observed young on 29 May 1971 on the study area. The data support G . R. Michener's (1973) estimate that breeding occurs in early April when females emerge from hibernation. The proportion of young being trapped increased rapidly for 2 weeks as litters reached the stage of above-ground activity. By late August young constituted 100% of the active population. The ratio of male to female young remained approximately 1:1 from emergence until the last half of August. In late August the proportion of young males increased relative to that of females and continued to increase until trapping terminated. This pattern remained substantially the same during all 3 years of the study.

Lactation

Prior to 5 May and after 8 June it was sometimes unclear whether a female was lactating or had lactated, so calculations of the proportion lactating include only females caught between these dates. In 1969, 1970, and 1971 the proportion lactating were 92.1% (82/89), 91.3% (73/80), and 100% (97/97). These high percentages suggest that all adult females can breed each year.

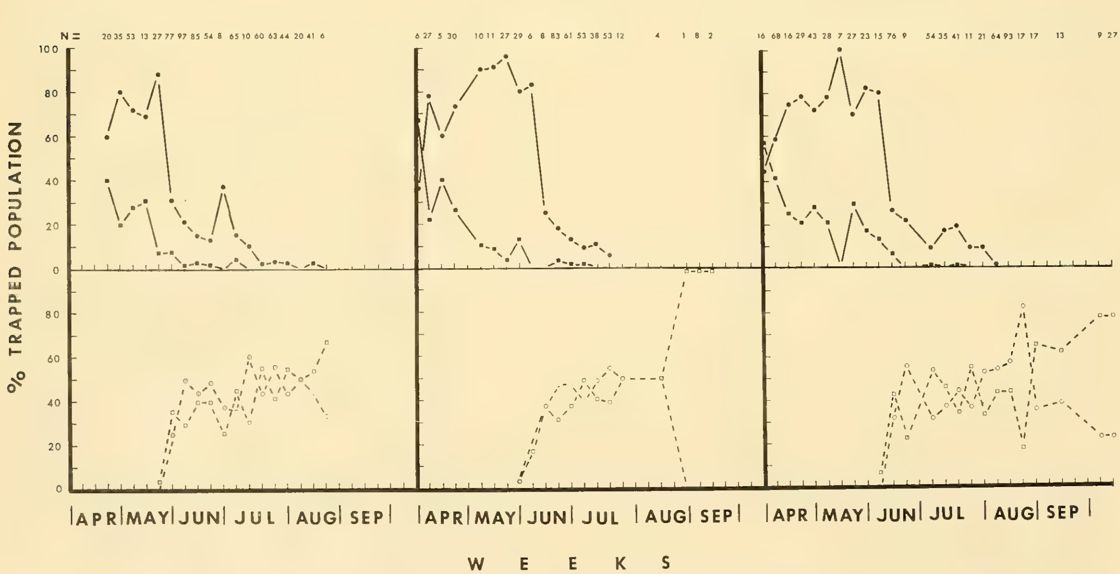

FIGURE 1. Weekly proportions of age and sex classes active in the population in 1969, 1970, and 1971. Adult males: ■ — ■ , adult females: ● — ● , young males: □ - - □ , young females: ○ - - ○ .

Growth and Weight Changes

During the study 701 weights were recorded from 351 adults, and 1136 weights were recorded from 917 young. Figure 2 summarizes these data. Significant mean differences between weights of male and female ground squirrels were obtained (Table 1), showing that both adult and young males were heavier than females of the same age classes. At the time of first emergence aboveground from the natal nest, weights of young males and females were similar. But young males rapidly became heavier than females as the summer progressed. Young gained weight during June and July each year. In 1971 weight gain levelled off in

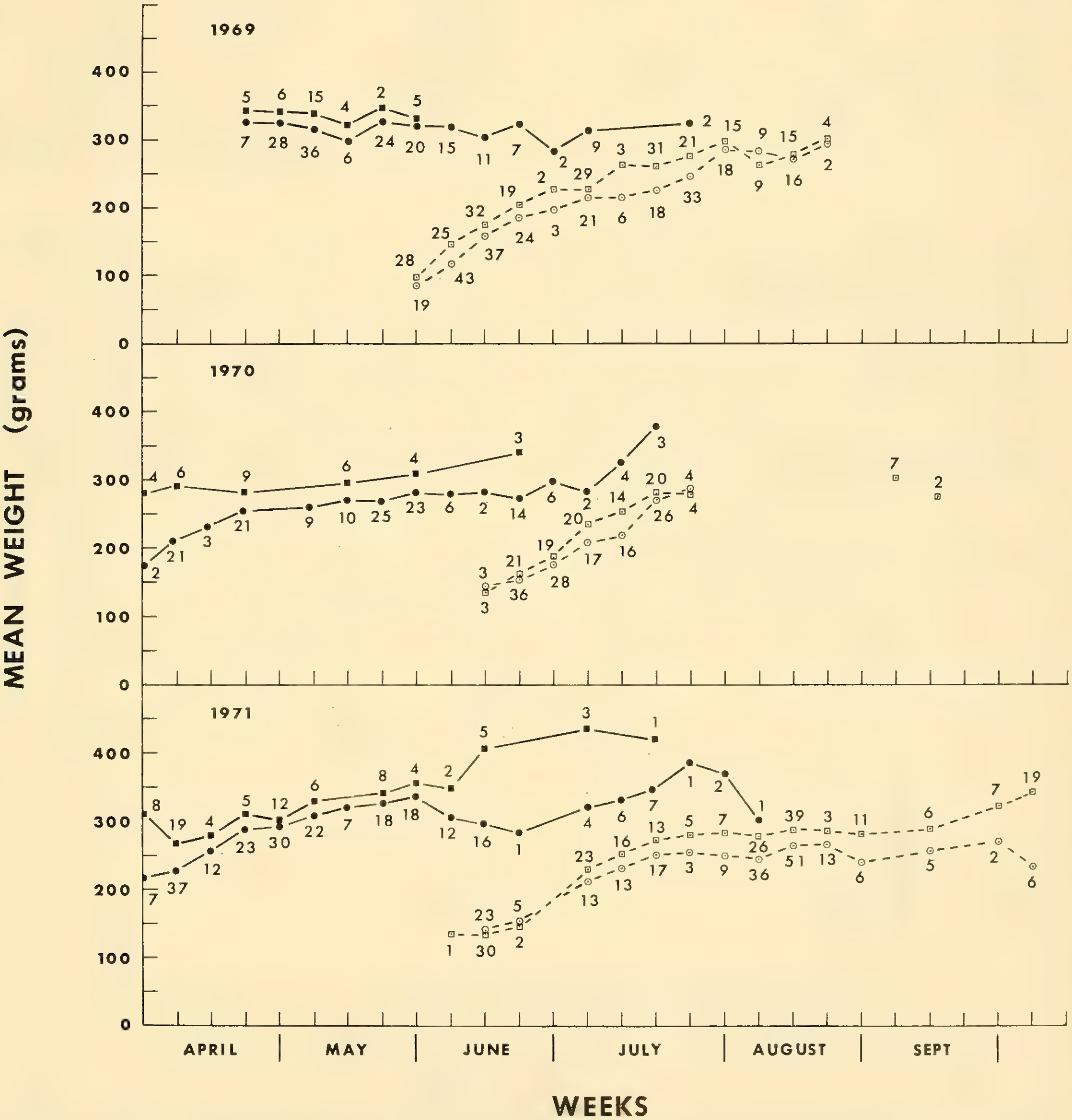

FIGURE 2. Mean weekly weights of ground squirrels trapped. Sample sizes are given. No individual's weight is included more than one time per week. Adult males: ■ — ■ , adult females: ● — ● , young males: □ - - □ , young females: ○ - - ○ .

TABLE 1 — Mean weekly weight differences* (in grams) between male and female ground squirrels

Groups		Mean difference, ± standard error
Adults	1969	27.7±5.1**
Adults	1970	48.4±5.5**
Adults	1971	35.4±4.5**
Young	1969	17.0±2.4**
Young	1970	10.3±3.4**
Young	1971	25.5±2.6**

*Computed from analysis of variance of weights of ground squirrels by weeks for males and females (Snedecor and Cochran 1937).
**Male vs. female F value significant at $P < 0.01$ level.

TABLE 2 — Mean prehibernation weight differences* (in grams) between squirrels which were not recaptured in the subsequent year and squirrels which were recaptured in the subsequent year

Groups		Mean differences, ± standard error
Young females	1969	−3.7± 4.0
Young males	1969	−1.2± 9.4
Young females	1970	−3.7± 4.8
Young males	1970	−9.1± 5.6
Adult females	1969	1.8± 4.4
Adult males	1969	−13.5±13.0
Adult females	1970	2.1± 4.8
Adult males	1970	−3.6±12.9

*Computed from analysis of variance of weights of ground squirrels by weeks for non-recaptures and recaptures (Snedecor and Cochran 1937).

late July, perhaps because of unusually dry weather. The reasons for the declines in mean weights of young in August of 1969 and 1971 are not known. One possibility is that the heavier animals hibernate earlier than the lighter ones, causing a drop in mean weights of active animals. Young entering hibernation tended to weigh less than adults entering hibernation (Figure 2). Yearling females emerged from hibernation significantly lighter than older females (Figure 3), but the difference in weights became insignificant after the first weeks of spring activity. No similar weight difference was obtained between yearling and older males in the spring. Larger sample sizes of males are necessary for statistical analysis.

Although mean differences between the prehibernation weights of squirrels which were recaptured in the subsequent year and squirrels which were not recaptured were not significant (Table 2), the data suggest that young males, young females, and adult males with greater prehibernation

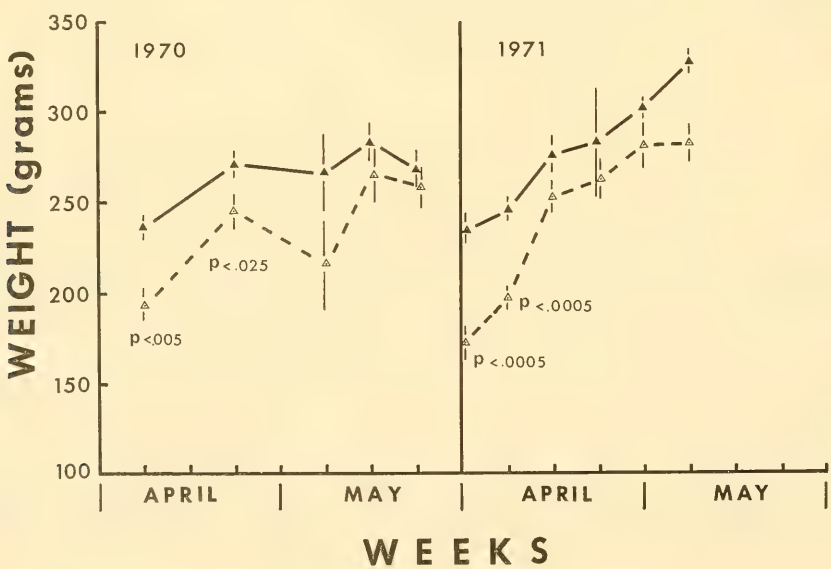

FIGURE 3. Mean weekly weights (± standard error) of yearling and older adult females after hibernation. Probabilities are given where t-tests show significant differences. No individual's weight is included more than one time per week. Yearlings: Δ - - Δ , older adults: ▲ — ▲ .

weights were more likely to be recaptured in the subsequent year than lighter individuals. This trend suggests that lighter individuals either dispersed from the study area or were less able to survive the winter period than heavier animals.

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A Survey of Bald Eagle Nesting Attempts in Southern Ontario, 1969–1973

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Weekes F. 1974. A survey of Bald Eagle nesting attempts in southern Ontario, 1969–1973. Canadian Field-Naturalist 88: 415–419.

Abstract. The Bald Eagle, *Haliaeetus leucocephalus*, was found on the verge of extinction in extreme southern Ontario, where breeding status during 1969–1973 was studied and compared with breeding status *circa* 1950 and earlier. Though formerly a common resident, the species has been subjected to too many adverse factors to maintain a steady breeding population. These adverse factors, any one of which might have been inadequate to destroy the total population, include general loss of habitat, nest destruction, shooting of individual birds, human disturbance during nesting attempts, and the probable contamination of their food by technologically-introduced toxicants.

An attempt was made during 1969–1973 to find all active nests of the Bald Eagle, *Haliaeetus leucocephalus*, in extreme southern Ontario, to compare current with former population and nesting attempts, and to note field conditions which might affect nesting.

Methods

Reports representing approximately 90 probable nesting pairs *circa* 1950 were collected and investigated. Physical search was made of 58 present or former nesting sites. Enquiries only were made of 32 former sites. Of the 58 areas searched, 8 had reports of current use; 15 had reports of sightings of Bald Eagles or rumors of nesting attempts; 20 had no recent reports of nesting attempts but contained sufficient wooded areas to make them possible, and 15 were said to be abandoned but still had potentially good nesting habitat. Of the 32 areas for which enquiries only were made, 21 had no reports of recent activity, 1 had a report of recent though not current activity, and 10 were reported definitely abandoned.

Where nests and apparently-mated pairs were found, checks were continued until the outcome for the season — young raised or nesting discontinued — was established. Search and observation were conducted from the ground and from aircraft. Some nests were climbed by others, but none by the author.

In 1969, the study covered Elgin and Middlesex Counties, and parts of Kent, Lambton, and Norfolk. By 1972 it had been extended to include, insofar as possible, that part of Ontario south of a line that might be drawn from Owen Sound eastward to the Ottawa River south of Pembroke, but including the Bruce Peninsula.

Observations were made from January to July. Sightings of adults or immatures without corroborative nesting evidence are not included in nest classifications.

The following sources were utilized in determining areas to be searched: local residents, literature studies, reports from 20 naturalists' clubs, records (incomplete) from the Canadian Audubon Society's participation in the continent-wide Bald Eagle survey of 1960–1965, and the Ontario Ministry of Natural Resources by way of record searches and canvassing of personnel.

Nesting Observations

Table 1 gives results of nesting activity noted. Ten nests were found active, with seven the highest number in use in any one year. Three nests were active during all five nesting seasons (1969–1973); one was active four seasons (1969–1972); one active two seasons (1971–1972) and probably a third (1973); one active two seasons (1969–1970), and four active one season each (1970, 1971, 1971, 1972).

Six eaglets left nests successfully. One fledged in 1969; one in 1970; three in 1971 (two from one nest); none in 1972; and one in 1973. Four different nests fledged young, but only one was successful more than once. It fledged a single eaglet in 1971 and in 1973. Of the 10 active nests found, eight were in extreme southwestern Ontario, and two in the northeast sector of the

surveyed area. All young were found within about 10 miles of Lake Erie.

There were 22 unsuccessful nesting attempts noted and one probable nesting attempt. At two of these one egg each was collected after normal incubation time had passed, in 1971 (Sergej Postupalsky and Marshall Field, personal communications). Broken eggshell was found in one nest in 1972 (Field, personal communication). The author found broken eggshell under an unsuccessful nest in 1970 and under another in 1971. An unhatched egg was noted on yet another 1971 nest at a date considered too late for hatching.

Over the 5-year period there were .22 young per active nest, and 1.2 young per successful nest and 19% of active nests successful.

Nineteen standing but inactive nests or remnants of nests were found. Some of these may have been supernumerary, but they appeared to represent at least 14 former nesting pairs. No standing remnants could be found at 34 other former nest sites for which active search was conducted.

TABLE 1 — Reproductive success at 10 nest sites of the Bald Eagle in southern Ontario between 1969 and 1973

Year	Nests found active	Nests found probably active	Successful nestings	Young known hatched	Young leaving nest successfully
1969	5	—	1	1	1
1970	6	—	1	2	1
1971	7	—	2	3	3
1972	6	—	0	0	0
1973	3	1	1	1	1
1969 to 1973	27	1	5	7	6

Former Range and Numbers

In a letter written to the Ontario Department of Lands and Forests, October 5, 1957, Charles Broley estimated there were still "some 100" Bald Eagle nests in the part of southern Ontario extending to North Bay and Sudbury. At one time the species was to be expected about the many large bodies of water of the province (Snyder 1932), and was noted throughout the Lake Ontario region and across to the Ottawa River (Vennor 1876; Ross 1871). It was still a fairly common resident of the Kingston area as late as 1960 (Quilliam 1965). W. E. Saunders has been quoted as saying that in the early 1900s there was an eagle's nest about every 5 miles along Lake Erie (Reynolds 1958), and at one time an eagle's nest about every mile from Port Stanley to Point Pelee (Reynolds 1960). This latter figure concurs with a density estimate made by Broley (1950) of a Bald Eagle's nest along every mile of Gulf coastline in Florida in 1939. The air distance along Lake Erie, excluding the Point Pelee, Rondeau, and Long Point marshes, is estimated at 212 miles, with the distance from Point Pelee to Port Stanley 72 miles (report of R. D. Ussher, Ontario Department of Lands and Forests naturalist, for Audubon Bald Eagle project, June 18, 1962). This would put Saunders' early 1900s estimate for the north shore at about 42 nests, and his one-time Port Stanley to Point Pelee estimate at 72.

In addition to nests along the main lakeshore, there were still known concentrations of Bald Eagle nests in the peninsular Point Pelee, Rondeau, and Long Point marsh areas as late as 1950. Bald Eagles were reported by Saunders (1930) and McIlwraith (1886) to have once been abundant along the Niagara Gorge.

A Pelee Island fisherman informed the author he would often count as many as 25 Bald Eagles on nearby Middle Island in the 1930s, and surmised that at least most came from the mainland. In current and former nesting areas of southwestern Ontario rural residents frequently told the author they commonly saw Bald Eagles "15 or 20 years ago" — around 1950. Whenever long-time residents, such as retired farmers or fishermen, were interviewed in current nesting areas, they would state that Bald Eagles had been nesting in the district as far back as they could remember.

Causes of Decline

One active nest was felled during the survey in a clearing operation for crop purposes. Cutting of commercial-size timber and general land-clearing were common throughout all the southern sector. The number of summer cottages was steadily increasing across the northern sector and along parts of the Great Lakes (noted by personal observation, and also documented by Eric Grove in a lakeshore research project for the Haldimand-Norfolk Joint Study Committee, 1973). The usual natural cause of loss of standing nests was storm

damage, particularly where nests were in dead elms. In two cases, erosion along Lake Erie caused the trees holding nests to fall into the water.

There were no known cases of any person's taking young birds, nor of taking of eggs before normal hatching time had elapsed. Three times where unsuccessful nesting attempts were noted, local residents told the author of human disturbances around the nests early in the attempted nesting (March or early April). The nest that fledged two young in one year was in a marsh area difficult of access. The nest that had two successful years was in an open area, but about half a mile from the nearest road and protected by the landowner from casual disturbance.

One case of direct disturbance of a Bald Eagle's immediate environment was recorded. The nest was still standing in 1969, but the birds had disappeared in 1964 after an oil well was drilled about 200 feet from the tree. Drilling hit salt water and oil, both of which spread through the surrounding swamp.

The pair that twice nested successfully appeared to be feeding in the spring mainly on carp, which would not be as high on the food (and pollution) chain as would a predaceous fish species. The pair that produced two eaglets in one season had access to an inland pond which does not appear to be directly susceptible to drainage from crop sprays.

No chemical analyses were made as part of this study, but environmental pollutants were found in all Bald Eagle autopsy specimens examined in one United States study (Mulhern et al. 1970), and in all Bald Eagle eggs in another (Krantz et al. 1970). Literature is abundant on possible correlations between environmental pollutants and reproductive failures of various avian species (Peakall 1970; Dahlgren and Linden 1971; Gress et al. 1971; Ratcliffe 1970; Cade et al. 1971; others).

Three mated pairs of Bald Eagles are known to have been broken up by shooting during the survey period, and one immediately prior, in the autumn of 1968. In only one case (1971) did a new adult join a survivor of a broken pair. Three earlier shootings are reported among nests active during the survey. At a nest used unsuccessfully in 1971 there had been no known activity since an adult bird had been shot in about 1966 (Postupalsky, personal communication). At a nest used unsuccessfully throughout the survey, the last known young had been shot off the nest in 1963. At another that produced one eaglet in 1969, the last previously-known young had also been shot off the nest, in 1962.

Illegal shooting was found to be the most common death cause of 69 Bald Eagle specimens at the Patuxent Wildlife Center in Maryland from 1966 to 1968 (Mulhern et al. 1970), but official data for Ontario are scarce. Only one Bald Eagle specimen was reported forwarded to the research division of the wildlife section of the Ontario Ministry of Natural Resources from 1963 to September 1972. The bird had died of natural causes (Edward M. Addison, Fish and Wildlife Research Branch, Ontario Ministry of Natural Resources, October 19, 1972 *in litt*). Among people who told the author of eagle shootings there was a tendency to wish not to become involved with authorities, particularly when this meant reporting on neighbors. The only times charges are known to have been laid were for the shootings of the eaglets off the nests in 1962 and 1963.

Conclusions and Discussion

It seems likely there were at least 100 active, and generally successful, Bald Eagle nests in this present study area up to about 1950, and perhaps twice that number early in the 20th century. Before settlement, the figure of one nest per mile would probably have prevailed along all the Great Lakes shores in the survey area, and nests would probably have been found on all the major creeks and rivers flowing into them. (See Table 2.)

TABLE 2 — Estimated number and decline of Bald Eagle nestings in southern Ontario

Time	Number	Outcome
Circa 1900	200 or more	Generally each rearing one or more young
Circa 1950	100 or more	Generally each rearing one or more young
Circa 1970	10±3 or 4	Generally rearing no young

Unique genetic pools appear to be on the verge of disappearance if sufficient birds cannot be produced from local nests to maintain the breeding populations. At one time it would have been expected that a new mate would be immediately available and taken when one Bald Eagle of a pair died for any reason (Herrick 1924). The long periods of inactivity following the shooting of one

adult would seem to indicate that migrants from northern Ontario — in at least part of which Grier (1969) has found Bald Eagles more numerous — do not automatically take the place of missing mates in southern Ontario. This could be because there are too few unmated adult migrants going through the depleted areas, or possibly because the northern birds are genetically conditioned to nest only in their native latitudes.

A more intensive search might reveal a few more nests. More intensive search and study, with attention to all aspects of nesting and feeding, might also clarify the reasons for the occurrence of more active and successful nests in the extreme southwestern area than in the lake country of the southeast.

Any attempt to save or restore the Bald Eagle as a breeding species in southern Ontario would probably require the following: (*i*) intensified search for remaining birds and nests, (*ii*) strong protective measures for individual birds and nests, (*iii*) preservation of suitable nesting and "cover" trees, (*iv*) provision of non-polluted food, (*v*) possibly placing of eggs or young from high breeding areas in active nests, (*vi*) better education or control of hunters, (*vii*) repeal of the law (or at least stricter supervision of it) that allows a person to shoot an eagle to protect his property. It might be possible to lure birds into better nesting areas, or keep them in good ones, by provision of food. Erection of protected nesting platforms near the food source might also be tried, especially if these could resemble normal nesting sites.

The decline and potential loss of the Bald Eagle in southern Ontario presents a pattern for study of the interrelating factors in the total socio-environmental situation. Any one factor might have difficulty wiping out a species (any species) but could become critical when other factors are treated separately and ignored because they belong to some other discipline or department. For instance, shooting of one eaglet from a nest in 1963 could be read as evidence that during at least a 10-year period 100% of known young from one county were killed by hunters. This would be true. It would also be highly misleading if it meant ignoring the reasons why this was the only nest left in the county, or why this was the only eaglet hatched in at least a decade of trying. The fact that humans do not lay eggs that might be made thin-shelled by pollutants does not mean we should ignore questions about other endocrine-controlled functions that might be being affected. The fact that one swamp is polluted should not obscure the fact that many others are being drained. An eagle's nest tree felled to obtain tobacco land is neither more nor less felled than are the millions sacrificed to obtain flooring or newsprint or to make way for subdivisions, airports, camp sites, parking lots, or sundry other forms of human enterprise.

If species are disappearing in a seemingly-inadvertent manner over which human society has no apparent control, something is being overlooked. Present specialization of interest and responsibility needs to give way to an approach that is not only interdisciplinary but also supradisciplinary in the sense of being subject to a more far-seeing set of values.

Acknowledgments

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Colonies of the European Snail *Helicella obvia* (Hartmann) in Ontario

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Grimm F. W. and G. B. Wiggins. 1974. Colonies of the European snail *Helicella obvia* (Hartmann) in Ontario. Canadian Field-Naturalist 88: 421–428.

Abstract. The occurrence of *Helicella obvia* (Hartmann, 1840), an eastern and central European land snail, in the vicinity of Bethany, Ontario, is discussed. This is the first North American record for the species. The snails are described and compared with related species, and their habits and the appearance of the colonies are discussed.

Introduction

Several localized populations of an introduced land snail, provisionally identified as *Helicella* sp., were discovered between 1969 and 1972 by the junior author in and near the village of Bethany, Durham County, 15 miles southwest of Peterborough in central southern Ontario. Specimens were subsequently determined to be *Helicella obvia* (Hartmann, 1840), a species native to southeastern and central Europe, and not previously recorded from North America. Dr. A. H. Clarke, head of the Invertebrate Zoology Section of the National Museum of Natural Sciences, Ottawa, and Mr. W. J. Byas of the U. S. National Museum, Washington, D.C., made the initial determination. Later this determination was confirmed by Dr. Leonard Kalas of the Department of Environment, Burlington, Ontario, a specialist on the molluscs of central Europe, and by the senior author, who examined the reproductive system of the snail and compared it with related forms.

Specimens are deposited in the collections of the Department of Entomology and Invertebrate Zoology, Royal Ontario Museum, Toronto, and the Mollusc Unit, National Museum of Natural Sciences, Ottawa.

Description of Adult Animals *(Figures 1, 2)*

Major diameter of shell from 12.1 to 18.6 mm, minor diameter from 9.0 to 13.0 mm, height from 5.8 to 8.3 mm. Whorls 4.75 to 5.25, evenly rounded except for the last 1/3 whorl which is somewhat flattened above the periphery and which descends before reaching the aperture. The descent of the last whorl is marked by an increase in its diameter; the aperture is somewhat oblique, the lip thin, sharp, and slightly thickened below. Spire low, conical, quite obtuse; umbilicus deep, funicular, perspective, exhibiting all the whorls. Nuclear whorl medium brown, slightly elevated. The rest of the shell is dull to slightly glossy, opaque white, solid, calcareous, marked with a single broad opaque dark-brown revolving band above the periphery, and up to six less distinct, lighter, often interrupted bands on and below the periphery. Often some of these bands are anastomosed or missing. There is a broad unmarked white zone around the umbilicus. Rarely a shell will be pure white or bear only a trace of the markings.

Externally the living animal is small (compared with the size of the shell). Its dorsal surface is subtranslucent ochraceous gray, shading into dull translucent ocher on the foot; the edge of the mantle is opaque ocher, finely peppered with lighter yellow, the vascular surface of the mantle is light gray, the blood vessels and the dorsal mantle edge outlined in darker gray. The genitalia are visible through the body wall.

Genitalia *(Figure 3)*

Atrium short; penis approximately 6 mm long, 1 mm wide, uniform, distally thickened, separated from the terminal epiphallus by a constriction and containing a large, thick, tapering blunt verge. Ephiphallus about twice the length of the penis, uniform in diameter, terminating in a short slender flagellum located near the insertion of the vas deferens, which is slender, thin, and about

FIGURE 1. Living *Helicella obvia*.

1½ times the length of the epiphallus. An extremely slender retractor inserts near the proximal end of the epiphallus. Attached to the vagina and immediately posterior to the atrium and the lumen of the penis are two large, irregularly ovate, muscular dart sacs, each containing a slender,

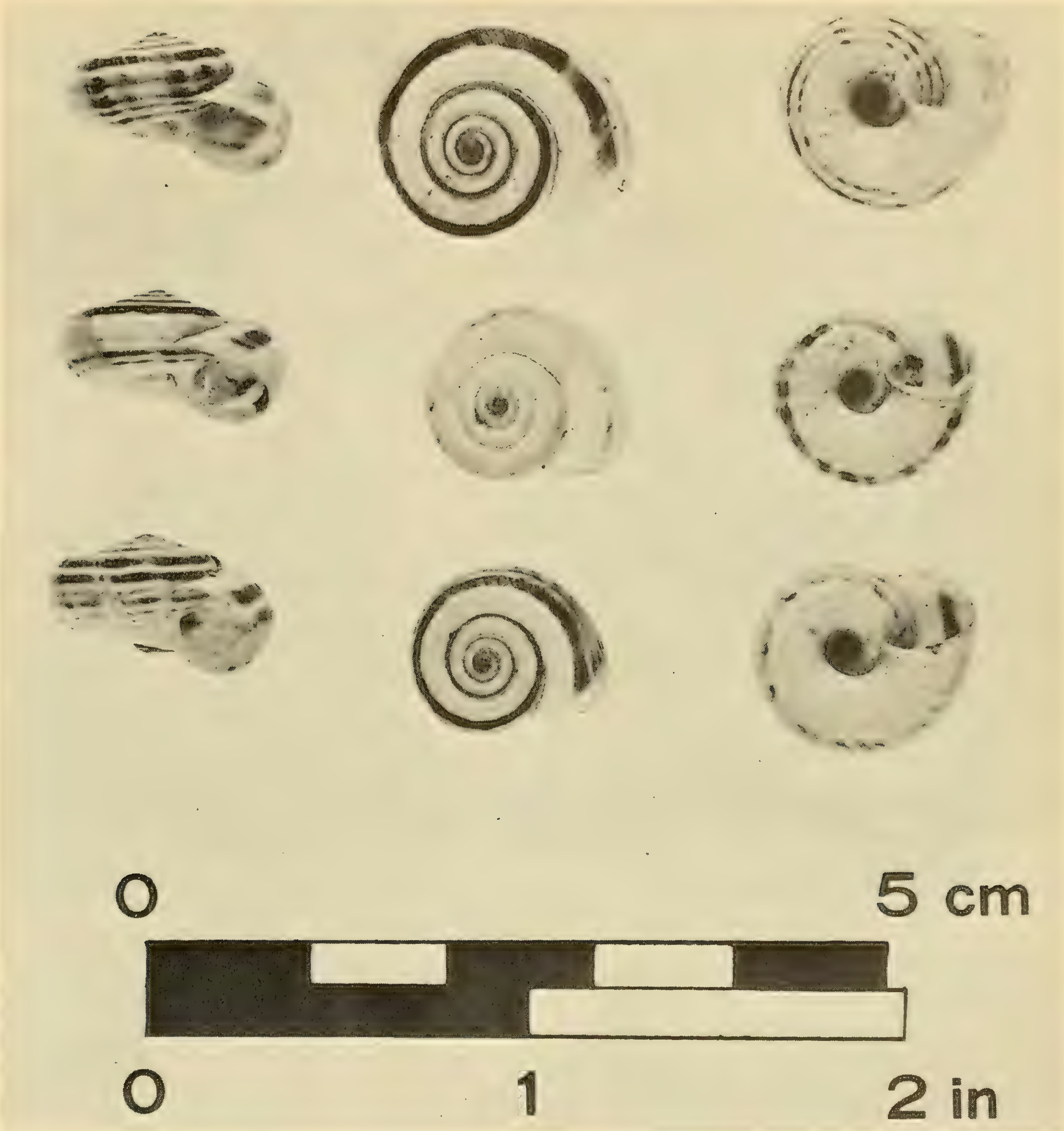

FIGURE 2. Shells of *Helicella obvia* showing variation in pattern.

tapering, curved, hollow, needle-like dart which is ellipsoid in cross-section. Immediately posterior to the dart sacs the short thick vagina branches off into a short free oviduct and a long white uniformly-thick spermathecal duct (slightly shorter than the epiphallus) which terminates in a translucent yellow, bean-shaped spermatheca. One spermatheca contained a tapered, flattened, slightly twisted spermatophore. At the junction of the spermathecal duct with the vagina is a group of thickly-digitate mucous glands. The posterior genitalia are characterized by a long granular white prostate gland, a wrinkled ocher oviduct, a brownish, flattened, curved albumen gland, and a long, slender, twisted, tan hermaphrodite duct. The rounded gray talon is hidden partially by the

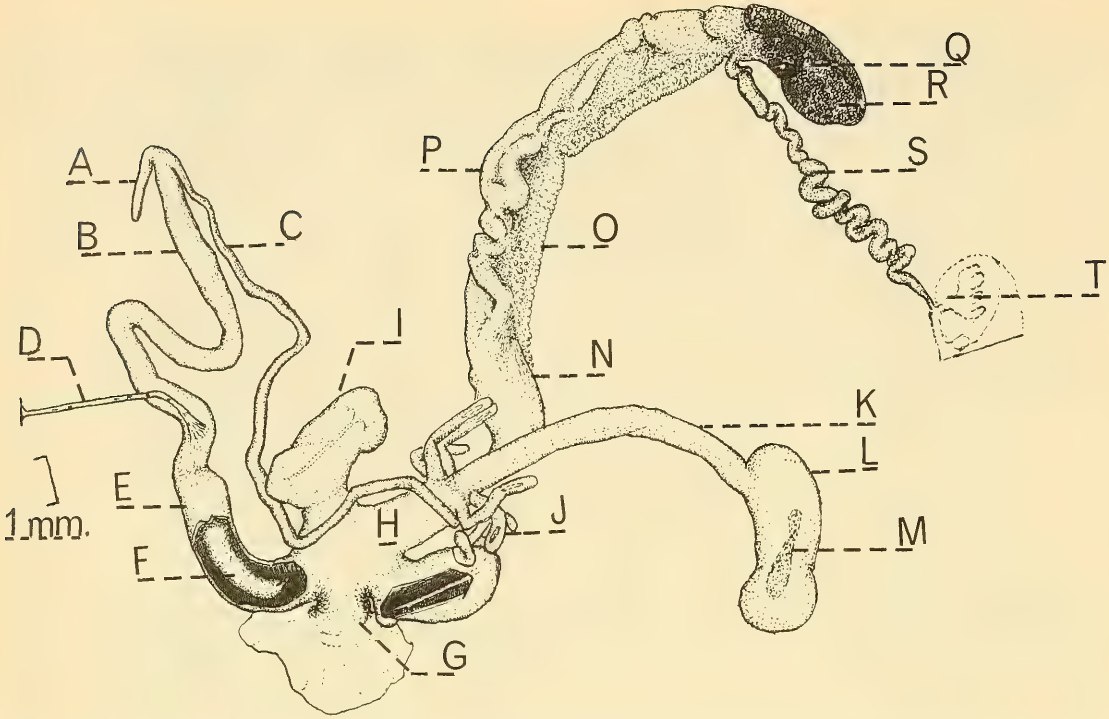

FIGURE 3. Genitalia of *Helicella obvia*, specimen from Bethany, Ontario. A - Flagellum, B - epiphallus, C - vas deferens, D - penial retractor, E - penis (shortened slightly by atrial expansion), F - verge, G - atrium, H - vagina, I - dart sac, J - mucous glands, K - duct of spermatheca, L - spermatheca, M - spermatophore, N - free oviduct, O - prostate gland, P - oviduct, Q - talon, R - albumen gland, S - hermaphrodite duct, T - ovotestis.

albumen gland. The many-branched ovotestis is hidden within the posterior portion of the hepatopancreas.

Similar Species *(Figure 4)*

The shells of *Helicella* (*Helicopsis*) *dejecta* (Christofori and Jan, 1832) of the Crimea, *Helicella* (*Cernuella*) *neglecta* (Draparnaud, 1805) of western and Mediterranean Europe, and *Helicella* (*Helicella*) *itala* (Linné, 1758) of western and central Europe resemble those of *Helicella* (*Helicella*) *obvia* (Hartmann, 1840) rather closely. In fact, the shell of *Helicella dejecta* is almost impossible to distinguish from that of *Helicella obvia*. The genitalia of all of these species differ considerably.

Helicella (*Helicopsis*) *dejecta* possesses four dart sacs (Hesse 1934, p. 25; Licharev and Rammel'meier 1952, pp. 477–480) arranged in two pairs. The outermost pair of sacs contains darts (Kalas, personal communication). The penis of *Helicella dejecta* is short and thick, that of *Helicella obvia* is long and slender (Hesse 1934).

The shell of *Helicella* (*Cernuella*) *neglecta* (Draparnaud) has more capacious whorls than that of *Helicella obvia*, the umbilicus is smaller, and the brown markings are lighter and less distinct (NMC 46295). *Helicella neglecta* possesses two dart sacs which are arranged asymmetrically on the vagina. A dart is present only within the larger, distal sac. The epiphallus and spermathecal duct are three times the length of the penis.

Both *Helicella* (*Helicella*) *itala* (Linné) and *Helicella* (*Helicella*) *obvia* (Hartmann) possess two dart sacs extending symmetrically from both sides of the vagina. The spermathecal duct of *Helicella itala* is three times longer than the penis, but the spermathecal duct of *Helicella obvia* is only twice the length of the penis. The shell of *Helicella itala* resembles that of *Helicella*

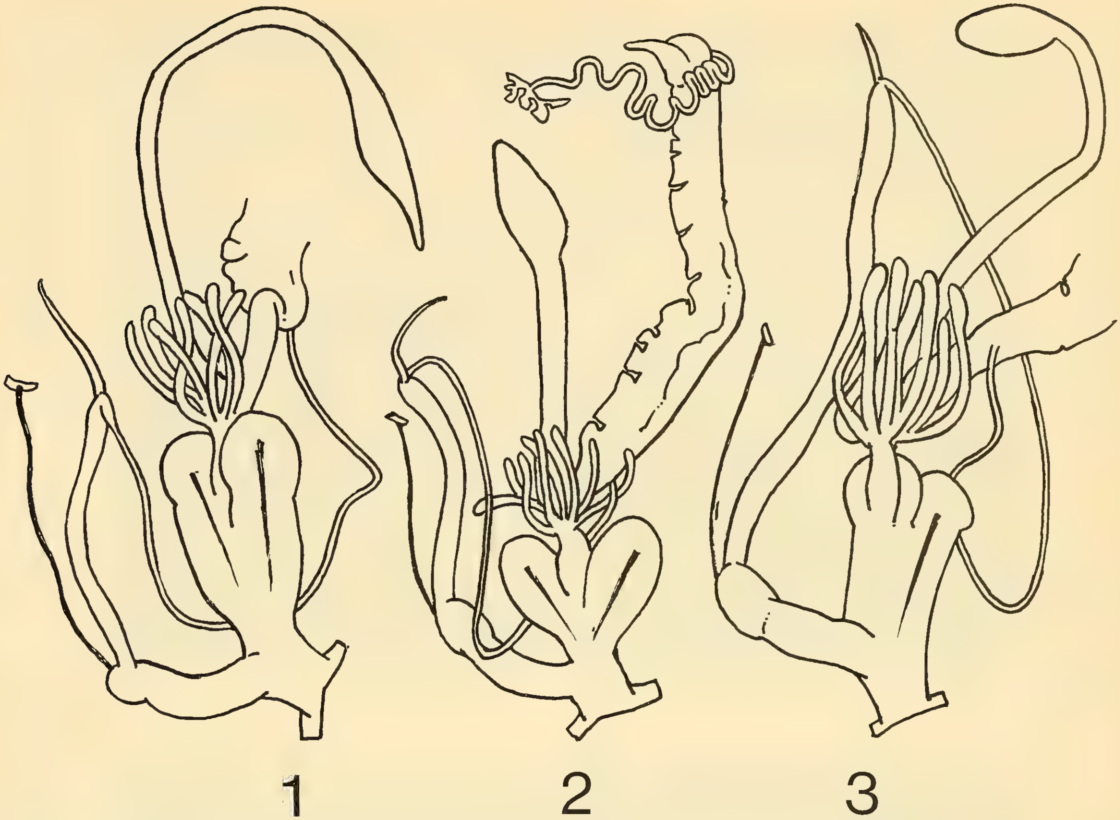

FIGURE 4. Genital systems in *Helicella* and *Cernuella* (after Kalas, personal communications).
1. *Helicella itala* (Linné), coastal area of southwest Netherlands, western Europe. 2. *Helicella obvia* (Hartmann), Vah River Valley, Slovak Carpathians, central Europe. *Cernuella neglecta* (Draparnaud), west of Rotterdam, Netherlands, western Europe. (Sketch 1 and 3 are based on drawings of E. Gittenberg, from Gittenberg et al. 1970.)

obvia in shape and size, but it is less calcareous. The brown bands on the shell of *Helicella itala* are translucent, whereas those of *Helicella obvia* are opaque.

Description of Colonies (*Figures 5, 6*)

Observations in 1971–1972 indicated that one colony was well established at the eastern end of Bethany, along both sides of the main paved road (Highway 7A) in an area extending eastward from the intersection of that road with an abandoned railway line for about 1/4 mile. Along the abandoned railway line, on both sides of the road, evidence of the snails disappeared within 200 yards of the road. Within this area, the snails appeared to be most numerous around a schoolhouse (converted to a private dwelling in 1967) situated a few yards north of Highway 7A. On the playground of the schoolhouse, the snails were abundant in the rich growth of grasses and herbaceous plants mowed to a length of 4 or 5 inches. Beyond this center of abundance the snails were numerous where plants were relatively sparse, principally on disturbed waste ground beside the road and the railroad. The sites inhabited by the snails were exposed, with few small trees or shrubs and much bare ground. Beneath cover in the railroad yard, only *Pupilla muscorum* (Linné, 1758) and *Vallonia costata* (Muller 1774) were found. Both of these are minute synanthropic holarctic calciphiles common in southern Ontario.

FIGURE 5. View of railroad at Bethany, Ontario.

FIGURE 6. Habitat occupied by *Helicella obvia*.

Examination of similar disturbed sites along the railroads in the vicinity yielded no *Helicella*. One small population was found on a road embankment at the intersection of a side road with Highway 7A, approximately 1/2 mile east of the railroad in the village. Another population was found in a pasture on a farm fronting on the south side of Highway 7A at the west edge of Bethany. The soils of all stations inhabited by these snails are derived from calcareous till. Examination of weed-lots on calcareous till within a 30-mile radius of Bethany failed to produce evidence of additional colonies.

Behavior

Unlike most of the land snails native to northeastern North America which require shelter, *Helicella obvia* lives in the open and avoids shelter. Throughout the year it may be found on clear ground devoid of plant cover, exposed at the bases of tufts of grass or climbing plants an inch or two above the ground in summer. In early November 1971, hundreds of examples were observed hibernating with the aperture up, exposed on bare ground. A few were at the bases of exposed plants. In these situations the snails seal the aperture with a thin epiphragm of dry slime, and withdraw deeply into the shell. Occasionally two epiphragms are formed, the inner one being thicker and slightly calcareous.

On 6 November 1971, a few eggs were observed at the bases of grasses. A few snails deposited eggs (one or two eggs per individual) within a few hours of capture on that date. The eggs were approximately 1 mm in diameter, rounded-ovate, calcareous, and subtranslucent. Unfortunately, they failed to hatch and were later lost. During the summer of 1972, no eggs were observed and all specimens captured failed to lay eggs. It is likely that oviposition takes place in late fall or early spring, but more observations are needed.

Throughout the year, most of the individuals observed have been living adults and subadult juveniles. A few smaller juveniles are present throughout the year, but they are greatly outnumbered by older examples. Throughout much of the colony, living examples appear to be slightly more numerous than shells. These observations indicate that, like most xerothermic land snails, *Helicella obvia* has long-lived adults which reproduce relatively slowly.

Helicella obvia is a sluggish inactive snail which moves about very little. It feeds upon dead herbaceous vegetation and ingests much soil from the surface of the ground. Often, bare patches of ground at Bethany are covered with a thin layer of blue-green algae when damp. This may serve as an additional food source. All fecal matter examined contained either fragments of dead herbaceous plants or large quantities of soil. No traces of green vegetation were found. It is likely that these snails pose no threat to agriculture. In the laboratory they accept fresh lettuce reluctantly (most snails relish it), and in the field it is evident that they do not feed upon green vegetation.

Predators

Shrews and rodents (probably voles and mice) appear to be feeding upon these snails at Bethany. Several small mammal burrows examined contained shells which had the spires or body whorls neatly removed in the manner characteristic of shrews, and many shell fragments were seen in mouse-runs.

History of the Colonies

Efforts to obtain information on the history of these colonies have met with some success, although their origin remains a mystery. The snails were already present on the schoolground, as described above, when it was purchased by its present owners in 1967. Laura and Thomas Morton (personal communication), owners of the farm on the western edge of Bethany, believe that the schoolyard colony originated on their farm. Miss Morton states in her letter that "Folks living near the school brought the snails from our farm to their garden, in the '40's . . . " It is quite likely that the snails have been on the farm for more than 50 years, possibly more than 70, according to the Mortons.

Acknowledgments

The authors take this opportunity to thank Mr. W. J. Byas, technician in the Division of Mollusks, U.S. National Museum, for helping to provide the identification of this snail. We thank Dr. A. H. Clarke, head of the Invertebrate Zoology Section of the National Museum of Natural Sciences, National Museums of Canada, both for

assisting with the identification of the snail and for critically reading the manuscript of this paper, and Dr. Leonard Kalas, malacologist of the Canada Centre for Inland Waters, Burlington, Ontario, both for confirming the identification and for his constructive criticism of this paper. Dr. Kalas also kindly provided the illustrations for Figure 4, which represents diagrammatically the genitalia of several species discussed in the text.

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Reproduction and Survival of Ditch-Dwelling Muskrats in Southern Quebec

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Stewart, R. W. and J. R. Bider. 1974. Reproduction and survival of ditch-dwelling muskrats in southern Quebec. Canadian Field-Naturalist 88: 429–436.

Abstract. The reproduction of a population of muskrats (*Ondatra zibethicus zibethicus* L.) living in drainage ditches at Mirabel, Quebec was studied. An average of approximately 400 yards of collection ditch containing permanent water was needed to support each breeding female. The first peak of litter production occurred from mid- to late May. Mean litter size ranged from 6.3 to 6.6 and females produced an average of two litters per year. The period of peak litter production, mean litter size, and average number of litters were similar to those of other populations in the same approximate latitude. High juvenile muskrat mortality occurred in animals under 6 weeks of age and during the winter following their birth. Muskrat survival expressed as the number of live young per breeding female in the population declined from 5.0 in the fall to 2.8 during the spring trapping season. This suggested that the opening of a fall trapping season in southern Quebec should be considered.

Introduction

The reproduction of the muskrat (*Ondatra zibethicus zibethicus* L.) has been reviewed by Errington (1963, pp. 51–62). Some variation in muskrat reproduction was evident among populations of different geographic regions. Because no data had been reported from southern Quebec it was not known if the reproduction of muskrats in this area conformed to that of populations in other regions of the same approximate latitude.

This paper presents reproductive data obtained during an ecological study of a ditch-dwelling population of muskrats in the Mirabel area of southern Quebec. Comparisons were made with other populations located in temperate Canada and the adjacent United States. The survival of young was traced through to the spring following their birth to identify periods of high mortality. Productivity expressed as the number of trappable animals produced per breeding female was evaluated, and management changes are suggested.

Study Area

The study area (45°38′ N, 74°10′ W) was located on the western edge of the St. Lawrence Lowlands, 7.8 miles east of Lachute, Quebec. Within the 1.8-square-mile area approximately 6.2 miles of collection ditches were connected to the feeder ditch systems draining the adjacent fields. The greater portion of the data originated from approximately 1.39 miles of collection ditch containing permanent water located in the core of the study area (Figure 1).

The bottom widths of the ditches varied from 3 to 8 feet, depths ranged from 1.5 to 8 feet, and bank slopes varied from 45 to 60 degrees. Normal water depth in various locations along the ditches ranged from 2 to 30 inches.

The dominant soil type was clay, except where patches of muck and glacial till occurred. The topography of the area was predominantly level, except where glacial deposits protruding through the clay created slight knolls.

Vegetation in the ditches consisted mainly of varying amounts of alisma (*Alisma triviale*), cut grass (*Leersia oryzoides*), beggar-ticks (*Bidens* spp.), and arrowhead (*Sagittaria latifolia*). The fields adjacent to the ditches were used for pastureland and hayfields or had been recently abandoned (Figure 1).

Methods

Several techniques were used during the study. Dates of peak litter production were estimated by back-dating sustained increases in muskrat activity related to population increases and by projecting the age of embryonic litters forward to their birth dates. Mean litter size and number of litters per breeding female were estimated using placental scar and embryo counts. The survival of young muskrats through to the spring following their birth was estimated using spring breeding territory counts, average placental scar counts per breeding female, and data from live- and kill-trapping programs.

The sand transect technique (Bider 1968), modified for use in drainage ditches, was used to

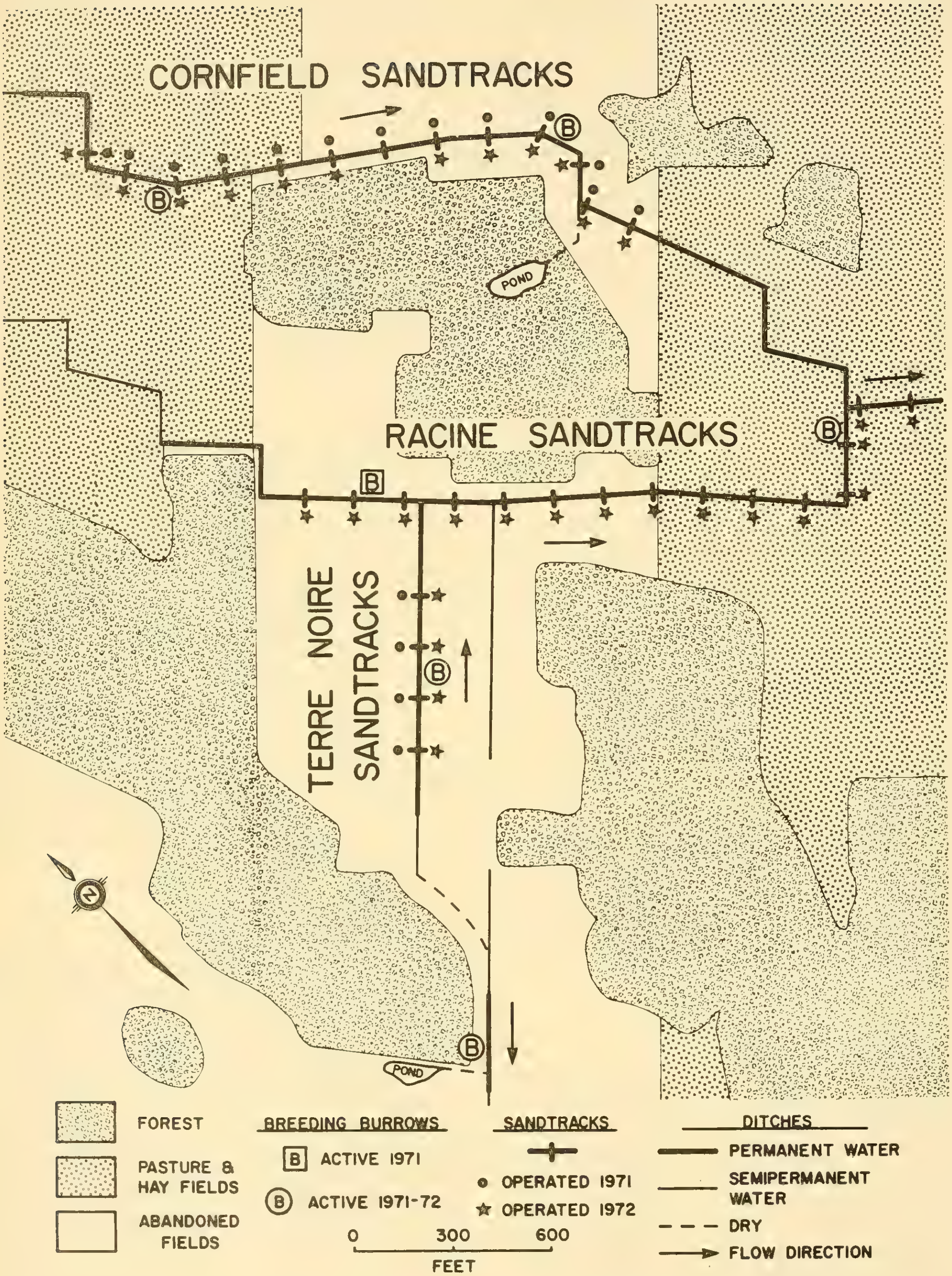

FIGURE 1. Map of the central core of the study area.

measure muskrat activity. Instead of continous transects, individual sandtracks were constructed across the ditches at 150-foot intervals. Each track consisted of a low 24-inch dam (top width) across the ditch, equipped with a box culvert to allow the passage of water. One end of the culvert was covered with 1-inch wire mesh, forcing passing muskrats to cross over the sandtrack. Fine sand was spread on the top surface of the dam to record muskrat tracks. Muskrat activity was expressed as the mean number of muskrat crossings recorded per sandtrack per day.

In 1971, 17 sandtracks were in operation from 8 June to 19 August (Figure 1). Continuous tracking data were not available since sandtracking was impossible when the uncovered sandtracks were wet from rain.

In 1972, 31 sandtracks were in operation from 24 May to 27 September (Figure 1). To allow sandtracking to continue through rainstorms, each sandtrack was fitted with a polythene canopy. A layer of 1-inch styrofoam was placed under the tracking surface to eliminate capillary-action wetting of the sand. In 1971, muskrats had occasionally burrowed through sandtrack dams. To eliminate this bias, each sandtrack and the adjacent ditch bottom was covered with 1-inch wire mesh before the styrofoam was installed. Data collection was still not continuous in 1972 because occasionally the ditches were flooded from the runoff of heavy rains. The activity rate of muskrats is greatly increased by rainfall (Stewart and Bider, unpublished data). Since increased activity on rainy days hindered the identification of shifts in the base muskrat activity level accountable to changes in population numbers, days with rain were excluded from the data.

From 7 July to 27 October 1972, the center core collection ditches (Figure 1) were live-trapped using unbaited Victor Tender Traps (Model #0750). V-shaped trap guides of logs or rocks were constructed from both trap openings to the ditch banks. Muskrats were sexed and aged according to Baumgartner and Bellrose (1943). The animals were weighed, total length and tail length measured, and toe clipped for identification. They were then released at their point of capture.

Two kill-trapping programs using Conibear #110 traps were carried out during the study. From 6 October to 10 October 1972, muskrats occupying the ditch containing the six northernmost cornfield sandtracks were trapped (Figure 1). From 16 April to 30 April 1973, the complete study area was trapped intensively in an effort to take as many individuals as possible. Olsen's (1959) method of aging muskrats was used to separate the spring-caught animals into three classes: adults (animals over 12 months of age), sub-adults (animals born late in the preceding breeding season and averaging 10 months of age), and juveniles (animals born late in the preceding breeding season and averaging 7 months of age). The uteri of visibly gravid females were removed, their embryos counted and preserved in 10% formalin.

In 1971 and 1972, the number of breeding territories located along the collection ditches was estimated by Sather's (1958) method.

Results and Discussion

Size of Breeding Territories

In 1971, six breeding territories were present in the central 1.39 miles of collection ditch. The following year two adjacent territories were occupied by a single breeding female (Figure 1). Breeding territories occupied an average of 408 yards of ditch in 1971 and 490 yards in 1972. In 1973, from late April trapping results, it was noted that the six breeding territories occupied in 1971 were again active. It appears that an average of approximately 400 yards of collection ditch containing permanent water was needed in our area to support a breeding female.

Spring Peak Litter Production

Bider et al. (1968) and Bider and Sarrazin (1972) described the use of cumulative frequency diagrams of animal crossings on sand transects to identify shifts in animal activity rates. Bider (1968) theorized that sustained increases in the daily activity of animal populations in the early part of the breeding season were linked to the addition of recruits in the population.

From the cumulative frequency diagram of the 1971 muskrat activity data, three sustained periods of activity (A, B, and C) were identified visually (Figure 2). The first surge in activity occurred on 29 June and the second between 12 July and 8 August. Period B was significantly greater in activity than A ($P<0.001$, Mann Whitney U test) and period C was significantly greater in activity than B ($P<0.05$). In 1972, three

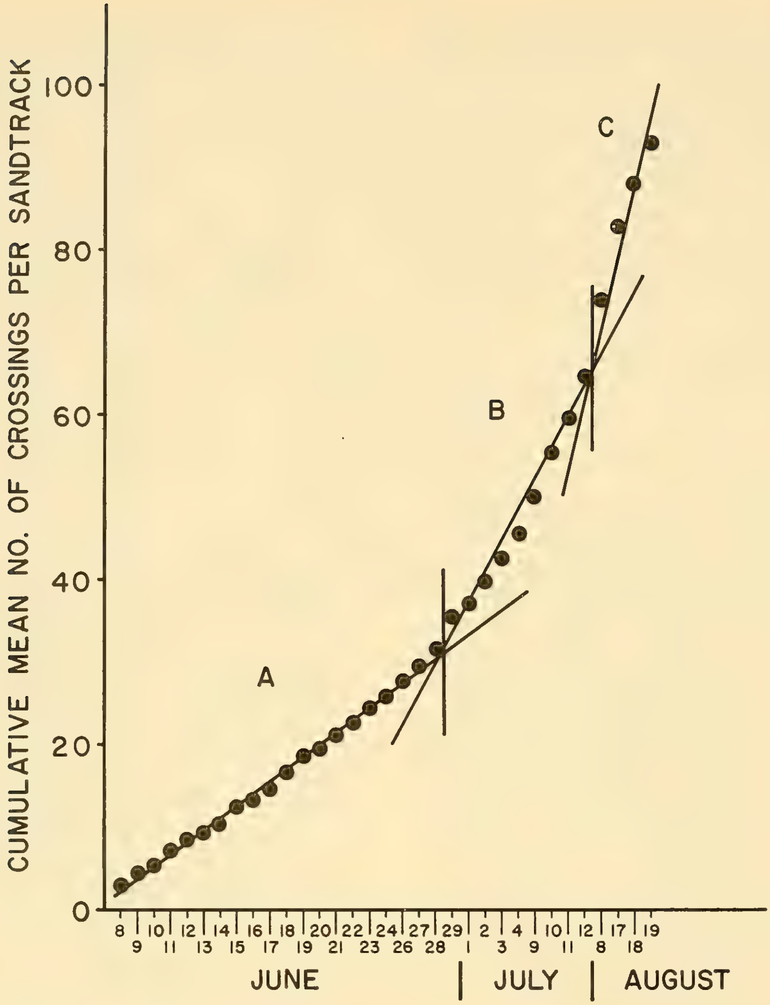

FIGURE 2. Cumulative frequency diagram of muskrat activity in 1971.

periods of activity (A, B, and C) were again evident (Figure 3). The first change in activity occurred between 19 June and 28 June (assumed to have taken place on 24 June) and the second between 12 July and 14 August. Period B was significantly greater in activity than A ($P<0.001$) and period C was greater than B($0.05<P<0.10$).

The mean weight of nine juvenile muskrats lived-trapped in 1972, when they first became active in the ditches, was 317 ± 7 grams. Using Errington's (1939) growth curves their mean age was estimated as 35 to 40 days (taken as 37 days). It was assumed that juvenile muskrats became active outside their natal burrows at the same age in 1971. An estimate of the first period of peak litter production in each year was calculated by back-dating the date of the first sustained increase in muskrat activity by 37 days. Since breeding is not completely synchronous, peak litter production was estimated to the nearest 10-day period surrounding the predicted date of peak litter births. In 1971, the first peak of litter production was between 21 May and 30 May and in 1972 between 14 May and 23 May.

McLeod and Bondar (1952), Dorney and Rusch (1953), Sather (1958), and Olsen (1959) found that a second peak of litter production followed the first by approximately a month. The

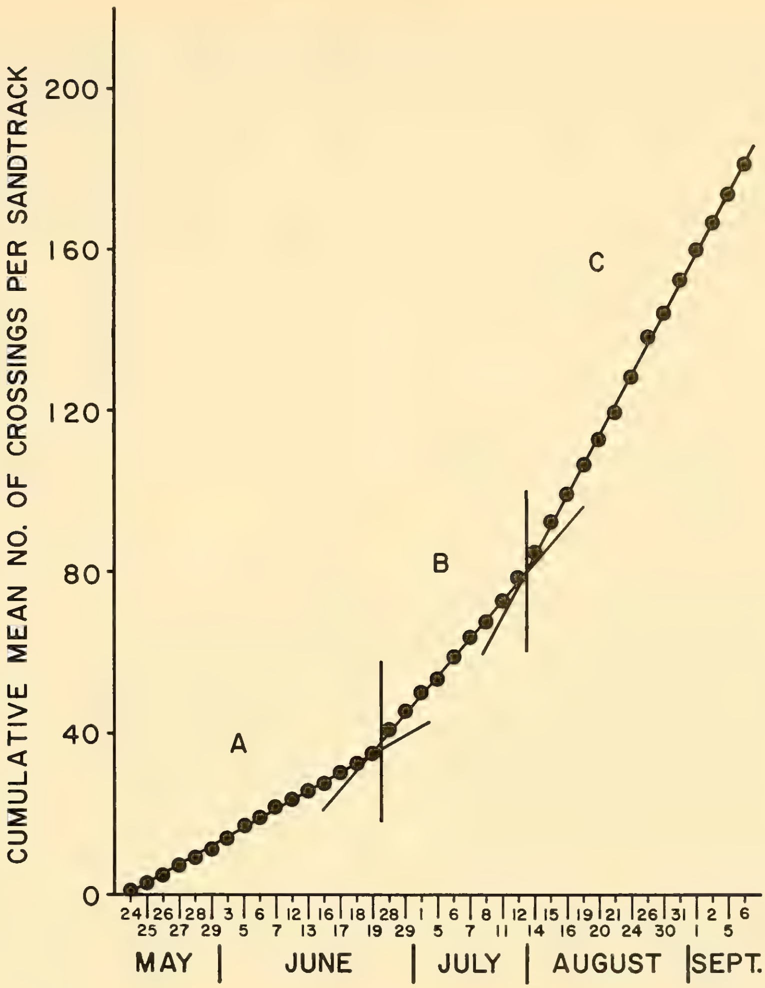

FIGURE 3. Cumulative frequency diagram of muskrat activity in 1972.

lack of data prevented the precise dating of the second increase in activity of period C in 1971 and 1972. But the interval between periods B and C in both years contains the period where the increase in muskrat activity from second litters would be expected if it followed the first by approximately a month.

To estimate the dates of the first peak of litter production in 1973 an adaptation of Dolbeer's (1973) method was used. We adjusted the fetal length growth curve of laboratory rats (*Rattus norvegicus*) by the ratio of 30 millimeters for rat birth-lengths (Altman and Dittmer 1962) to 100 millimeters for muskrat birth-lengths (Errington 1939). The mean fetus length of each muskrat litter was applied to the simulated growth curve to obtain its estimated embryonic age. The number of days required to complete the gestation period of each litter was added to the capture date of the female, yielding an estimated birth date. The predicted birth dates were estimated to the nearest 5-day period of the month to allow for the difference between the 22-day gestation period for rats (Altman and Dittmer 1962) and an assumed 25-day gestation period for muskrats (Beer 1950; McLeod and Bondar 1952).

Sixteen of 32 female muskrats trapped in the spring of 1973 were visibly pregnant and one female trapped on 30 April had a greatly distended uterus, indicating it had just given birth.

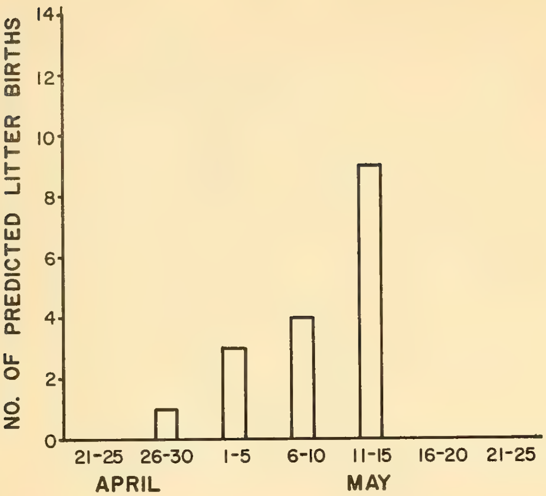

FIGURE 4. Frequency of predicted muskrat litter births in 1973.

The number of litter births per period followed the first half of a normal distribution curve with the first estimated litter birth date occurring between 26 April and 30 April (Figure 4). If the litters from the 15 visibly non-pregnant females were assumed to complete the latter half of the curve, a high number of litter births would be expected between 16 May and 20 May. Thus the projected peak litter production in 1973 occurred between 11 May and 20 May.

Similar periods of peak litter production in mid-to late May were found in Wisconsin (Beer 1950), southern Manitoba (McLeod and Bondar 1952), and the Athabaska-Peace Delta (Fuller 1951). Sather (1958), however, found that in Nebraska, the first peak of litter production occurred in late April – early May.

Number of Young per Litter

Studies by Beer and Truax (1950), Errington (1951; 1963, p.61), Sather (1958), Olsen (1959) and others have reported mean litter sizes from five to eight for O. *z. zibethicus*, with the majority of authors reporting litter sizes of six to seven. From the 16 gravid females taken in our area during the spring of 1973 the mean litter size was 6.6 ± 0.3.

Although not significantly different ($0.20<P<0.30$, Student's t-test) the mean litter size of sub-adults was larger than those of the juvenile females (Table 1). Both Sather (1958) and Errington (1963, p.61) found indications that precocial females (animals breeding in the year of their birth) had smaller litter sizes than normal breeders. Olsen (1959) hypothesized that undeveloped reproductive tracts and possibly poor winter food conditions caused juveniles to give birth later than older females. Possibly the juveniles in our area were not sufficiently mature to produce the same number of young in their first litters as sub-adults.

TABLE 1 — Number of embryos per female.

Age class	Sample size	Number of embryos: Range	Number of embryos: Mean ± standard error
Juveniles	10	5–8	6.3±0.3
Sub-adults	6	6–8	7.0±0.5
Total	16	5–8	6.6±0.3

Number of Litters

From our data, it appears that the mean number of litters per female was two in our study area. In 1972, three fall-trapped females had 13, 11, and 12 placental scars. One 1973 spring-trapped adult female whose placental scars were still visible had implanted 14 embryos in the previous breeding season. If each of these females had given birth to two litters, their mean litter size for the breeding season of 1972 was 6.3. This agrees closely with the mean litter size of 6.6 for the first litters of the 1973 season. The second increase in muskrat activity in 1971 and 1972 (Figures 2 and 3) further supports the hypothesis that most females produce at least two litters during each breeding season.

This agrees with the pattern of an average of two litters per female in temperate Canada and the adjacent United States as reported by McCann (1944) for Minnesota, Gashwiler (1950) for northern Maine, Fuller (1951) for the Athabaska-Peace Delta, McLeod et al. (1951 (*cited* by Olsen 1959)), and McLeod and Bondar (1952) for southern Manitoba. Although no evidence of third litters was found, it is possible that they occurred.

Survival of Young

To identify periods of high mortality among young muskrats, the survival of animals born in the 1972 breeding season was followed until their harvest in the 1973 spring trapping season.

In 1972, the females occupying the five breeding territories in the core area were estimated to have produced 62 young. This estimate was determined by multiplying the average number of placental scars (12.5) of the four females available from the 1972 breeding season by the number of breeding territories. Three of the four females were known to have bred within the core area.

During the live-trapping and fall kill-trapping programs, 34 young, 35 to 40 days or older, were caught. Also five breeding females and six breeding males, probably the full complement of adults in the breeding territories, were live-trapped. Although the number of young surviving to an age where they became active in the ditches is a minimum estimate, the success in trapping the adults suggests that few young muskrats escaped capture.

If possible embryonic resorption is ignored, 34 young muskrats (an average of 6.8 per adult female) survived to an age of 35 to 40 days. Thus a possible 28 or 45% of the estimated original cohort of 62 did not survive longer than approximately 6 weeks of age. It is unknown what mortality factors accounted for this high rate of loss.

From both live- and kill-trapping data, 30 of 32 animals (two muskrats were lost in handling accidents), or 94% of the 6-week-old cohort were alive in September or October. During the kill-trapping program in October, three young were removed, leaving a possible 27 marked muskrats (13 females and 14 males) to enter the winter. It was assumed that no muskrats moved into or out of the core area until the spring dispersal period. Fuller (1951), Shanks and Arthur (1952), Sather (1958), and others reported that few young muskrats moved beyond their original home ranges (place of birth) during the summer and fall months. Of these animals, 11 or 41% were trapped in April 1973.

The estimated 59% loss of the fall muskrat population over the winter would be biased upward by two factors: firstly, that not all the surviving muskrats were trapped in April 1973; and secondly, that all 27 animals were not available to start the winter in November. None of the nine male and all of the seven female sub-adult and juvenile muskrats taken in the core area during the spring were marked. Of 26 male and 24 female sub-adult and juvenile muskrats trapped outside the core of the study area four males and one female were marked. Male muskrats are known to travel much longer distances than females during the spring dispersal period (Sather 1958; Errington 1963, p.74). Possibly, a few males may have survived the winter and moved out of the spring-trapped area. If two of the 27 muskrats assumed to have survived through October had died (the same number of deaths as the assumed pre-September loss of muskrats over 6 weeks of age) and three additional males had survived but were not trapped in the spring, a possible 14 of 25 individuals may have survived the winter. Taking these biases into account, a possible 11 of 25, or 44% of the estimated fall population of young muskrats died during the winter.

These results indicate that most of the young-muskrat mortality occurred between birth and 6 weeks of age and during the winter months. Errington (1951, 1954) has shown that the survival rate of young muskrats is inversely related to the density of the spring breeding population and (1943, 1951) that muskrat mortality from different sources is compensatory.

We estimated that approximately five young per breeding female survived to enter the winter in November. Baumgartner and Bellrose (1943) in Michigan, McCann (1944) in Minnesota, Gashwiler (1950) in Maine, Fuller (1951) in the Athabaska-Peace Delta, and Olsen (1959) in southern Manitoba reported the survival rate of young muskrats to the fall or early winter. The number of young per breeding female in their studies ranged from 4.8 to 14.0. The high pre-winter rate of juvenile-muskrat mortality (principally animals under 6 weeks of age) suggests a high spring breeding population relative to the quality of the muskrat habitat of our area. As prior to the spring of 1973 the muskrat population had not been trapped for at least 5 years (A. Racine, personal communication), this is to be expected. A reduction in the spring breeding density through trapping should increase the survival rate of young muskrats through the actions of the inverse density principle.

Our data indicate that nearly one-half the fall population of young muskrats are lost before the opening of the spring trapping season in southern Queben. An estimated 2.8 young per breeding female survived to the spring following their

birth. This suggests that a late fall or early winter trapping season should be opened to replace, through the compensatory mechanism of muskrat mortality, the heavy winter losses of muskrats from natural causes. But further study is needed to measure conclusively the effect of a fall trapping season on muskrat spring population levels. To determine the best series of dates for such a season, this study must also establish when muskrat fur becomes prime in southern Quebec, and the latest date that open water remains in the ditches to facilitate muskrat trapping.

Conclusions

The first peak of litter production, the average number of litters, and the mean litter size of muskrats in the Mirabel area were similar to other muskrat populations in temperate Canada and the adjacent United States. The highest rates of young-muskrat mortality occurred in animals under 6 weeks of age and during the winter months. The low survival of young indicated that the Mirabel population was at a high level relative to the quality of the habitat. Muskrat productivity, when expressed as the number of young per breeding female surviving to the spring trapping season, was low. The opening of a fall or early winter trapping season in southern Quebec (in addition to the spring trapping season) should increase the number of trappable animals.

Acknowledgments

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The Distribution of Aquatic Plants in Selected Lakes of Gatineau Park, Quebec[1]

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Aiken, S. and J. M. Gillett. 1974. The distribution of aquatic plants in selected lakes in Gatineau Park, Quebec. Canadian Field-Naturalist 88: 437–448.

Abstract. Ninety-six species of aquatic plants have been recorded for 21 lakes of Gatineau Park, located in Pontiac and Gatineau Counties, Quebec as a result of a field survey conducted in 1971 and by examination of herbarium specimens. Fifty-two species were the most recorded for any lake; two lakes had fewer than 10 species. The diversity found in lakes so close together is attributed to the recent (11,600 Before Present (B.P.)) denuding of the area by the Wisconsin Glaciation followed by the inundation of some, but not all of the lakes, by the Champlain Sea. The present distribution of aquatic plants reflects the isolated positions of some lakes relative to others, the limited accidental transfer of aquatic plant material to lakes of higher elevation, and the short growing season.

Introduction

Gatineau Park is well situated for a study of the aquatic lake flora because it spans an interesting geological zone from the Laurentian Shield to the northern margin of the Ottawa – St. Lawrence Lowland. Before 11,600 B.P. the Champlain Sea was at its maximum in the Gatineau Park area (Buckley, J. Gatineau Park Geomorphology. Unpublished report (1967), prepared for the National Capital Commission by the Division of Quaternary Research and Geomorphology Department, Energy, Mines and Resources) and according to Gadd (1962) only the land now over 650 feet remained above sea-level. Because certain lakes such as Meach, Carmen, Brown, and Lapêche were flooded by the Champlain Sea when other lakes such as Kingsmere, Kelly, and Curly were not, it was considered of interest to compare the two groups.

The past and present distribution of terrestrial plants and many animals was strongly influenced by the existence of the Champlain Sea. For plants, this is shown by the present distribution of the grasses (Dore 1959), and by the pollen profiles found in Quebec bogs (Potzger 1953). For animals it is shown for the present distribution of fish in Gatineau Park Lakes (Rubec 1973), and is brought out in discussions by Harington (1971) and Wagner (1970) on the vertebrate fossil fauna.

This study was begun as part of a collective series of studies directed by M. Dickman of the Biology Department of Ottawa University, for the National Capital Commission in the summer of 1971 and the results were presented in a report to the Commission (Aiken, S. G. Water plants in Gatineau Park Lakes. Limnological baseline study, Gatineau Park Lakes. National Capital Commission, unpublished report (1971). pp. 69–80).

[1]Contribution Number 910 from the Plant Research Institute.

Methods

An aquatic plant was defined by Fassett (1956) as "one which may under normal conditions germinate and grow with at least its base in the water, and which is large enough to be seen with the naked eye." Vascular aquatic plants had been collected in Gatineau Park before 1971. An indication of the extent of previous work was gained by surveying the specimens of aquatic plants in the herbaria of the National Herbarium (CAN), the herbarium of the Plant Research Institute, Agriculture Canada, Ottawa (DAO), and the Carleton University Herbarium (CCO). Approximately 60 species were recorded in these herbaria, from 14 Gatineau Park Lakes, but no comprehensive study of an entire lake had been made and very few of the submersed aquatics had been collected.

In 1971 surveys of the lakes were made by canoe, and occasionally by aluminum boat. Specimens were collected with a garden rake, or by wading or swimming for them when this was more feasible. The entire margin of each lake to

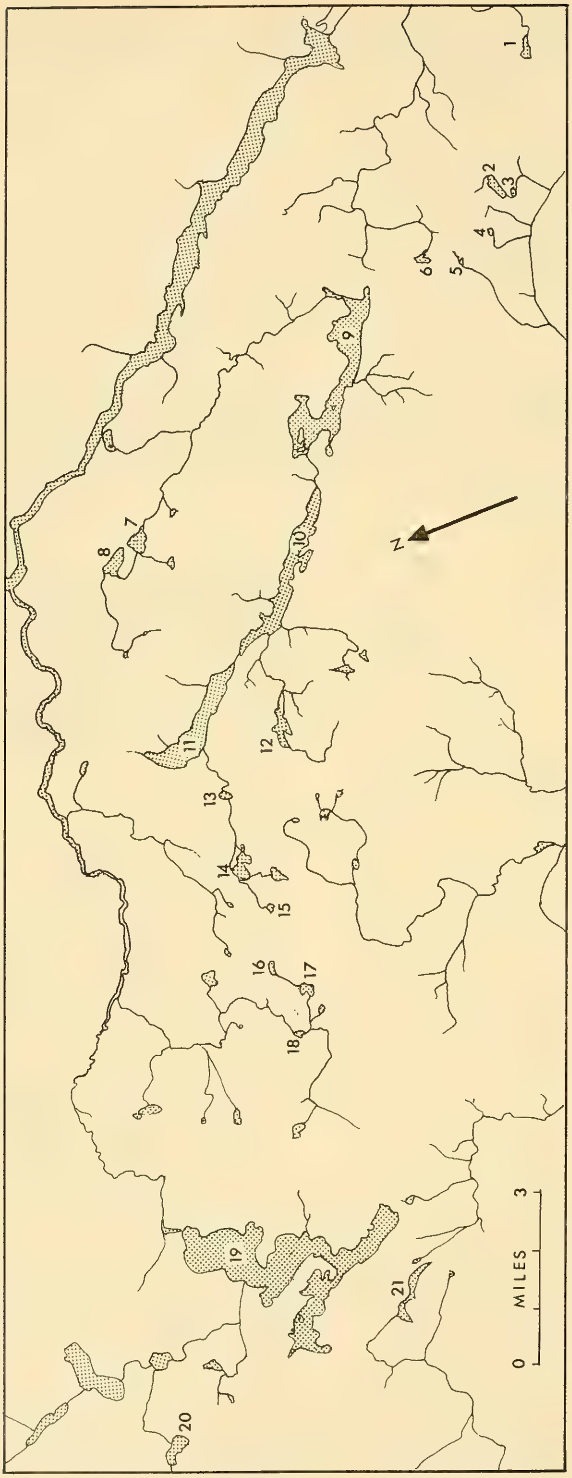


FIGURE 1. Map of Gatineau Park showing location of 21 selected lakes: 1. Pink, 2. Kingsmere, 3. Mulvihill, 4. Black, 5. Bourgeois, 6. Fortune, 7. Carmen, 8. Brown, 9. Meach, 10. Harrington (Mousseau), 11. Philippe, 12. Lusk, 13. Renaud, 14. Taylor, 15. Mud, 16. Kidder, 17. Ramsay, 18. Holly, 19. Lapêche, 20. Kelly, 21. Curley.

visible depth was surveyed and every species seen was recorded. Specimens required for further identification and for vouchers were prepared. Approximately 100 specimens were deposited in the DAO herbarium. The numerous aquatic specimens collected earlier by Gillett in the Park for use in studies of the flora were also examined and included in the records in Table 1.

The 21 lakes surveyed were selected to include lakes from every region of the Park (Figure 1); Five Lakes, Pink, Meach, Philippe, Ramsay, and Kidder were chosen for more intensive study and visited at monthly intervals to check the influence of seasonal changes. These lakes were also mapped in detail to show plant distribution. The technique used varied with individual lakes. In Pink and Kidder Lakes, which have relatively few plants, it was possible to indicate the species and sometimes the number of plants directly on the map. To obtain a numerical indication of the difference in vegetation patterns in lakes with richer floras, a variety of techniques were tested. The method adopted was to employ a large map of each lake, and to divide the shoreline into equal lengths, arranged so that whole bays were included in a given unit of length where possible. Points on the shoreline were projected towards the center of the lake, dividing it into 10 areas such that the amount of littoral zone was roughly the same in each area. When surveying a lake by boat, every species found in an area was recorded. A numerical estimate was made of the abundance of each species, in each lake area, on a 1–10 subjective coverage scale in which 1 indicated solitary, 2 relatively rare, 3 and 4 sparse, 5 and 6 common, 7 and 8 frequent, 9 dense, and 10 very dense. Some allowance was made for differences in plant size, so that 10 represented at least 500 plants for a small plant such as *Eriocaulon* and 50 for a plant such as *Nuphar*. This information was recorded in tabular form, and was summarized by adding the number of species in each area, and comparing the total obtained with the total of all the abundance numbers which had been allotted for the area.

During the boat surveys, note was taken whether certain species, or combinations of species, act as indicators of conditions in the aquatic environment. The geographical position of large weed beds in lakes, and the direction and influence of the prevailing wind was also observed.

Results

A species list of aquatic plants found in Gatineau Park is recorded in Tables 1 and 2. To give a more complete record, all species found in the survey and species which had been recorded earlier in the three herbaria searched, are included in these tables. Most of the additional species from herbaria included could appear as marsh or land plants in a dry season, as the distinction

TABLE 1 — The distribution of common aquatic plants in Gatineau Park Lakes. *indicates species present; ×indicates supplementary records from herbaria.

Species list	Pink	Kingsmere	Mulvihill	Black	Bourgeois	Fortune	Carmen	Brown	Meach	Harrington	Philippe	Lusk	Renaud	Taylor	Mud	Kidder	Ramsay	Holly	Lapêche	Kelly	Curley
Acorus calamus L.											*							*	*		
Alisma triviale Pursh																	*×		*		
Brasenia schreberi Gmelin.						*	*	*	*	*	*	*	*	*			*	*	*		*
Calla palustris L.				*			*		*												
Callitriche palustris L.							*		*									*	*		
Cladium mariscoides (Muhl.) Torr.					*												*×		*		
Ceratophyllum demersum L.					*		*	*	*		*		*								
Chara (Algae)	*	*	*					*	*		*		*	*	*						
Decodon verticillatus (L.) Ell.								*×		*×											
Dulichium arundinaceum (L.) Britt.		*	*	*	*	*	*		*			*	*	*	*	*	*	*	*		*
Elodea canadensis in Michx.								*	*	*	*			*					*		
Eleocharis acicularis (L.) R. & S.					*	*	*	*	*	*		*		*	*	*	*		*	*	
E. obtusa (Willd.) Schultes			*	*						*	*							*	*		
E. palustris (L.) R. & S.					*	*	*		*		*	*		*					*		
Eleocharis sp.	*			*					*	*		*									

TABLE 1 — *(Continued)*

Species list	Pink	Kingsmere	Mulvihill	Black	Bourgeois	Fortune	Carmen	Brown	Meach	Harrington	Philippe	Lusk	Renaud	Taylor	Mud	Kidder	Ramsay	Holly	Lapêche	Kelly	Curley
Eriocaulon septangulare With.						*×	*		*	*	*	*		*	*		*		*	*	*
Equisetum fluviatile L.		*						*	*	*	*	*		*		*			*	*	
Heteranthera dubia (Jacq.) MacM.								*	*		*										
Hypericum ellipticum Hook.				*			*					*					*	*	*		*
Isoetes sp.				*					*	*	*	*							*		*
Juncus balticus Willd.		*					*	*													
J. brevicaudatus (Engelm) Fern.												*			*				*		
J. effusus L.			*			*						*									
Lemna minor L.	*				*		*		*				*					*	*		
Leersia oryzoides (L.) Sw.				*				*											*		
Ludwigia palustris L.			*							*×	*×										
Megalodonta beckii (Torr.) Greene						*	*		*		*		*	*	*				*		
Myriophyllum alterniflorum DC.									*		*	*									
M. exalbescens Fern.									*	*	*	*	*	*					*		
M. verticillatum L.									*		*				*			*	*		
Myrica gale L.							*	*	*×	*×	*×	*	*	*×			*	*	*		
Najas flexilis (willd.) Rosth. & Schmidt		*			*	*	*	*	*		*		*	*	*		*	*	*		
Nitella (Algae)									*		*	*						*	*		
Nuphar variegatum Engelm.			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Nymphaea odorata Ait.							*	*	*	*	*	*	*	*	*		*	*	*		
Polygonum amphibium L.	*				*	*	*						*					*	*		*
Potentilla palustris (L.) Scop.																	*	*	*		
Pontederia cordata L.						*	*	*	*	*	*	*	*	*			*	*	*		
Potamogeton alpinus Balbis											*							*	*		
P. amplifolius Tuckerm.	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
P. berchtoldii Fieber		*	*		*	*	*	*	*	*	*		*	*	*		*	*	*		*
P. epihydrus Raf.				*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
P. gramineus L.					*	*	*	*	*	*	*			*			*		*	*	*
P. natans L.	*		*		*	*			*			*	*	*			*	*	*	*	*
P. richardsonii (Ar. Benn.) Rydb.								*		*	*	*			*				*		*
P. robbinsii Oakes							*	*	*	*	*			*			*	*	*		
P. spirillus Tuckerm.							*	*	*	*	*						*				
P. vaseyi Robbins							*		*		*								*		
P. zosteriformis Fern.						*		*	*		*		*					*	*		
Ranunculus flammula L.											*×								*		
Sagittaria graminea Michx.									*		*										
S. latifolia Willd.	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	
Scirpus subterminalis Torr.						*			*			*					*	*	*		
S. validus Vahl.									*		*										
Scirpus sp.	*	*	*	*		*			*			*		*			*				
Sium sauve Walt.				*					*×									*			
Sparganium americanum Nutt.						*			*		*×		*								
S. androcladum (Engelm.) Morong							*	*	*	*						*					
S. angustifolium Michx.				*		*			*	*		*		*	*				*		
S. chlorocarpum Rydb.							*		*							*		*			
S. eurycarpum Engelm.																			*		
Sparganium sp.			*	*	*					*		*	*	*	*						
Spirodela polyrhiza (L.) Schleid.					*			*	*										*		
Typha latifolia L.	*	*	*	*	*	*	*	*×	*	*	*	*	*	*			*	*	*	*	
Utricularia gibba L.													*				*	*	*		
U. intermedia Hayne						*			*				*				*	*			
U. vulgaris L.				*	*	*	*		*				*		*		*	*	*		*
Vallisneria americana Michx.							*	*	*	*	*	*		*					*		*

TABLE 2 — Plants found in only one Gatineau Park Lake

Species	Location
Bidens sp.	Black Lake
Butomus umbellatus L.	Planted beside Kingsmere Lake, June 1971
Calamogrostis canadensis (Michx.) Beauv.	Lac Bourgeois
Carex hystericina Muhl.	Black Lake
C. interior Bailey	Ramsay Lake
C. lasiocarpa Ehrh. var. *americana* Fern.	Lac Bourgeois
C. stricta Lam.	Pink Lake
C. vesicaria L.	Meach Lake
Eleocharis intermedia (Muhl.) Schultes	Brown Lake
Glyceria striata (Lam.) Hitchc.	Lusk Lake
Hydrocotyle americana L.	Lac Philippe
Juncus dudleyi Wiegand	Black Lake
J. filiformis L.	Lac Lapêche
Lemna trisulca L.	Lac Bourgeois
Lobelia dortmanna L.	Lac Philippe
Lysimachia terrestris (L.) BSP	Lusk Lake
Myriophyllum humile (Raf.) Morong	Ramsay Lake
Nymphaea tuberosa Paine	Probably planted in Kingsmere Lake, escaped into Mulvihill, 1971
Onoclea sensibilis L.	Mulvihill Lake
Polygonum punctatum Ell.	Lac Philippe
Potamogeton praelongus Wulf.	Lac Philippe
Rhynchospora alba (L.) Vahl	Ramsay Lake
Sagittaria cuneata Sheldon	Fortune Lake
S. rigida Pursh	Lac Lapêche
Salix serissima (Bailey) Fernald	Pink Lake
Scirpus atrocinctus Fernald	Kingsmere Lake. Late fruiting. Many "*Scirpus*" in Table 1 are this species or closely related to it
Typha angustifolia L.	Lac Lapêche
Utricularia minor L.	Meach Lake
U. cornuta Michx.	Ramsay Lake
U. resupinata B. D. Greene	Ramsay Lake
Wolffia sp.	Holly Lake

between marsh plants and aquatic plants is not always clear-cut. Other species in this borderline category might also have been listed. Thus, species numbers are not absolute, but useful as a tool for discussing the diversity observed.

A total of 96 species of plants have been recorded from 21 lakes; 65 of these species have been found to occur in more than one lake. This information is summarized in Table 1, which lists the 65 species occurring more than once. Plants found in only one lake are listed in Table 2. Table 3 lists the number of species found in each lake and the present elevation of the lake.

TABLE 3 — Number of species recorded and present elevation of 20 Gatineau Park Lakes. Harrington Lake is not included on this Table as it was incompletely surveyed.

Lake	Number in Figure 1	Height above sea-level, in feet	Number of species
Bourgeois	5	985	21
Black	4	982	19
Lusk	12	930	19–30*
Fortune	6	925	24
Mud	15	829	17
Kelly	20	778	8
Kingsmere	2	795	13
Mulvihill	3	741	15
Kidder	16	679	9
Taylor	14	677	29
Renaud	13	660	25
Ramsay	17	657	31
Holly	18	654	32
Curley	21	648	15
Lapêche	19	593	52
Philippe	11	564	44
Meach	9	559	51
Pink	1	532	11
Brown	8	474	25
Carmen	7	473	32

*Lusk Lake has 19 aquatic species and 11 species which are usually considered marsh plants growing in shallow water at the marshy margin of the lake.

The maps showing the distribution of water plants in the five lakes studied in detail are shown in Figures 2–6. The tabular data obtained for Meach, Philippe, and Ramsay are available from the Depository of Unpublished Data, National Science Library, National Research Council of Canada, Ottawa, Canada K1A 0S2. Observations on the five lakes follow.

1. *Pink Lake*. Figure 2

This lake had a maximum of 11 species and four of these were found only in the shallow waters at the mouth of the inlet stream (Figure 2). This low number of aquatics is attributed to the very rocky littoral zone in most of the lake, the isolated position of Pink Lake relative to other lakes in the Park, and to the alkaline, calcareous water which would be expected to deter the

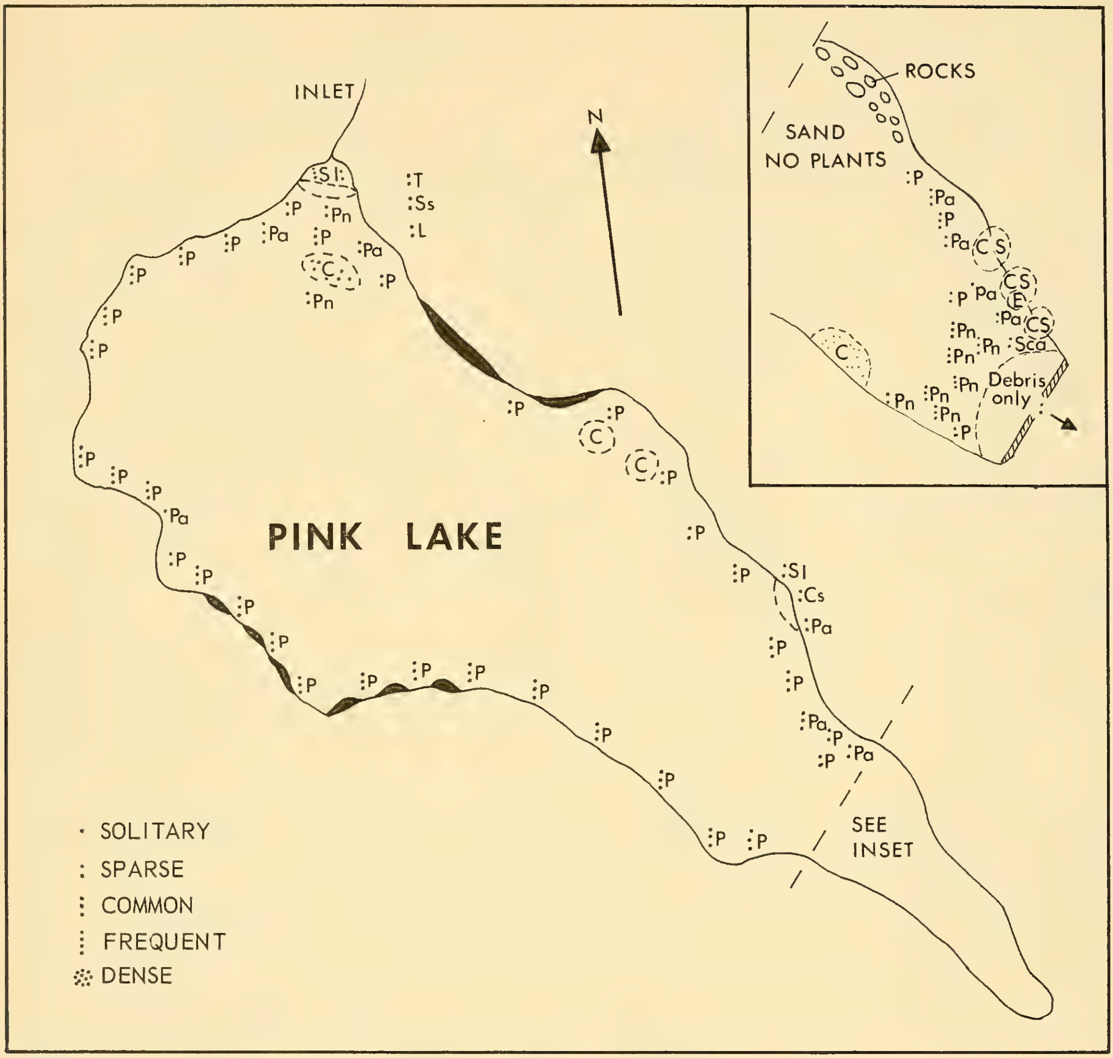


FIGURE 2. Map of Pink Lake. Solid rock is shown by a thickened line at lake margin. C=*Chara* (Algae), Cs=*Carex stricta*, E=*Eleocharis* sp., L=*Lemna minor*, P=*Potamogeton amplifolius*, Pa=*Polygonum amphibium*, Pn=*Potamogeton natans*, Sca=*Scirpus atrocinctus*, Sl=*Sagittaria latifolia*, Ss=*Salix serissima*, T=*Typha latifolia*.

growth of some species. The dominant plant was *Potamogeton amplifolius* Tuckerm. The large leaves of this plant were green in spring but became white with deposits of calcium carbonate as the bicarbonate equilibrium shifted towards carbonate during the summer. The deposits weighed down the plant and caused a more prostrate appearance than usual.

2. *Kidder Lake*. Figure 3

So few species occurred in this lake that it was possible to count the exact number of individual plants in many locations. But there is much shallow shoreline where plants might reasonably be expected to grow. In a survey conducted in June, only one plant of *Nuphar variegatum* Engelm. was found in the lake and it occurred near the inlet. By the end of August this plant was well established although it had not flowered. At this time two more *Nuphar* plants had become established some 20 feet from the first. Several *Potamogeton amplifolius* plants were observed near the inlet end of the lake and small numbers

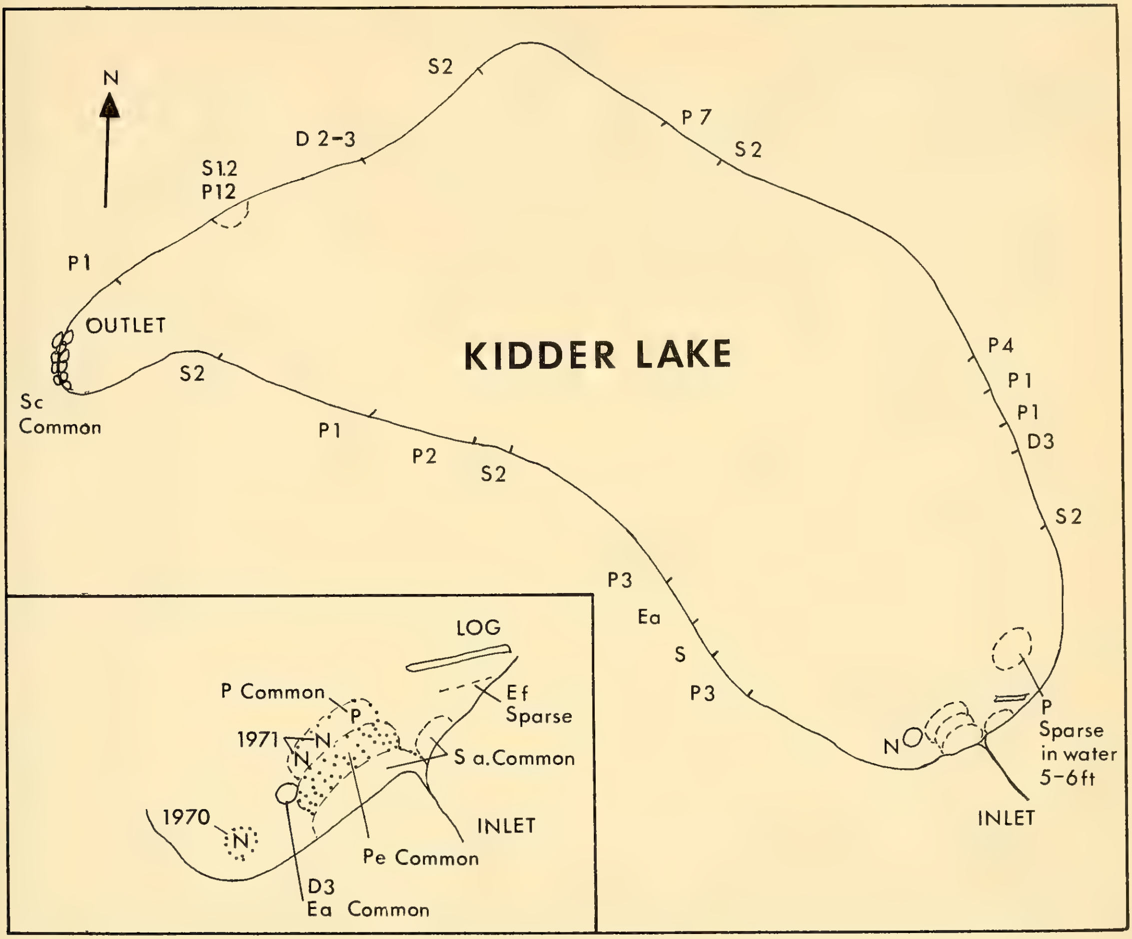


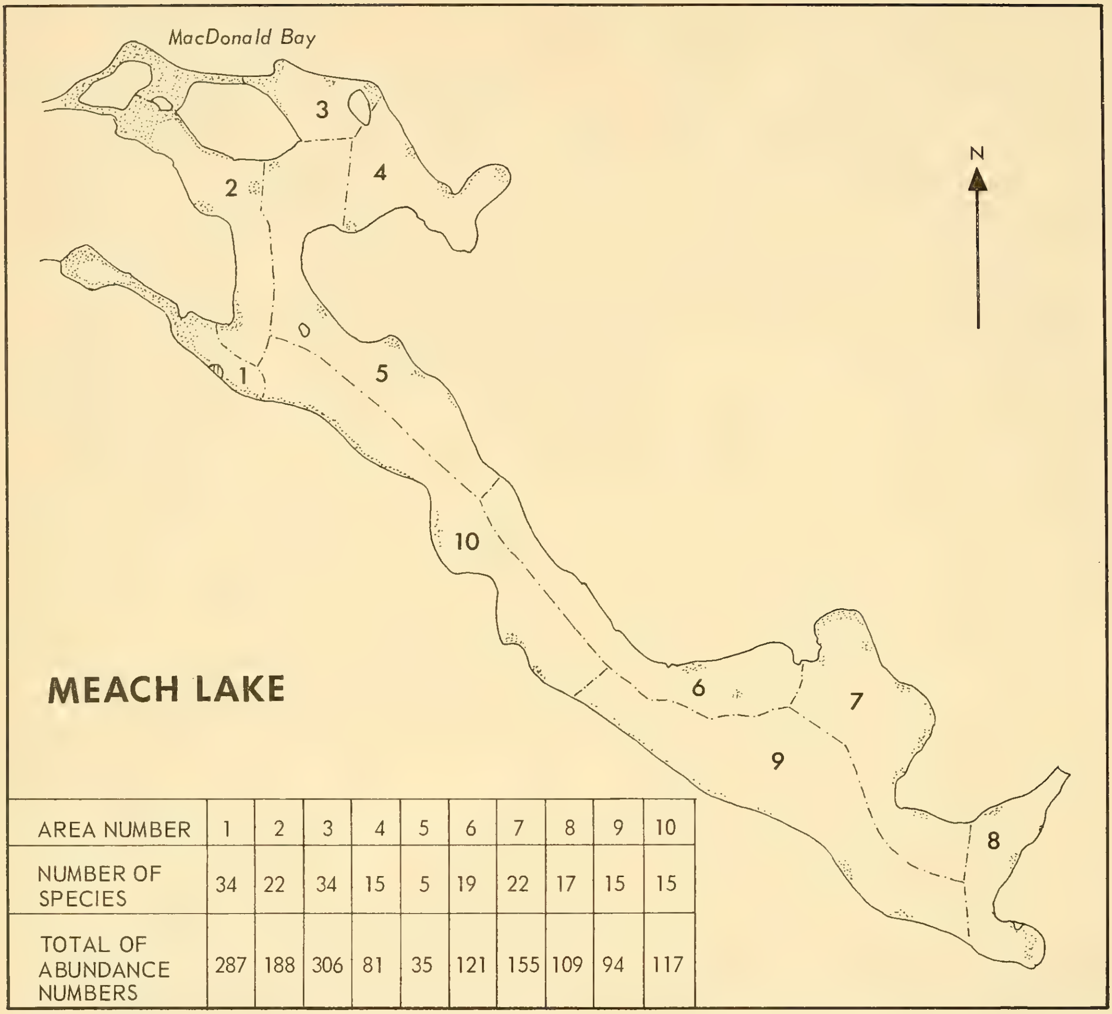
FIGURE 3. Map of Kidder Lake. A number after an abbreviation signifies the number of plants of the species at that site; for example, P4 indicates four plants of *Potamogeton amplifolius*. D=*Dulichium arundinaceum*, Ea=*Eleocharis acicularis*, Ef=*Equisetum fluviatile*, N=*Nuphar variegatum*, P=*Potamogeton amplifolius*, Pe=*P. epihydrus*, S=*Sparganium* (did not fruit in 1971), Sa=*S. androcladum*, Sc=*Sparganium chlorocarpum*, S1=*Sagittaria latifolia*.

of this plant occurred in several other areas. At the inlet, where silt is deposited, and where the lake water is aerated and mixed with that of the inlet stream *P. amplifolius* grew in 5–6 feet of water, but elsewhere it grew in water 1–2 feet deep near the shoreline.

3. *Meach Lake*. Figure 4

In areas 1 and 3 a total of 34 species was found and the total abundance numbers 287 and 306 respectively, indicate that many of the species were present at maximum density on the scale used. By contrast, area 5 had only five species and a total abundance number of only 35. The numerical values emphasize that area 3 (Macdonald Bay) had a high density of aquatics, while area 5 consisting of rocky exposed shore, had a low aquatic plant density. The range of aquatic plant abundance varied between these extremes in the other areas of the lake. Area 9 may have originally supported more aquatic vegetation but natural conditions have been altered by the use of rock fill in road construction along the shore and by the dumping of sand for beaches.

The water entering Meach Lake from Harrington flows through very dense beds of over 30 species of aquatic plants and presumably seeds from these plants are distributed throughout the



AREA NUMBER	1	2	3	4	5	6	7	8	9	10
NUMBER OF SPECIES	34	22	34	15	5	19	22	17	15	15
TOTAL OF ABUNDANCE NUMBERS	287	188	306	81	35	121	155	109	94	117

FIGURE 4. Map of Meach Lake. Map divided into 10 areas used in the study. Data from surveys of the areas are summarized at the top of the figure.

lake. The greater density of aquatic vegetation in the Macdonald Bay area is attributable to its sheltered position. Other parts of the lake are exposed to the prevailing wind and subsequent wave action which together prevent the establishment of plants in otherwise suitable substrates.

4. *Lac Philippe*. Figure 5

Lac Philippe and Meach Lake are sufficiently alike in size for comparison. Like Meach, the highest abundance numbers for Philippe are obtained in the northwest bays. But by comparison with Meach Lake, the smaller quantity of plant material and the smaller number of species in Lac Philippe is reflected in the total of abundance figures of 130 and 105. Eutrophication was not nearly as advanced in Philippe's northwestern bay, possibly because this bay is not as sheltered as Macdonald Bay in Meach Lake where high hills and an island prevent almost all wave formation. There are four inlet streams into Philippe, and different plant species are found in the littoral zone opposite each. Much of the original south

AREA NUMBER	1	2	3	4	5	6	7	8	9	10
NUMBER OF SPECIES	19	21	4	2	7	14	13	11	1	10
TOTAL OF ABUNDANCE NUMBERS	130	105	32	11	28	69	49	60	2	76

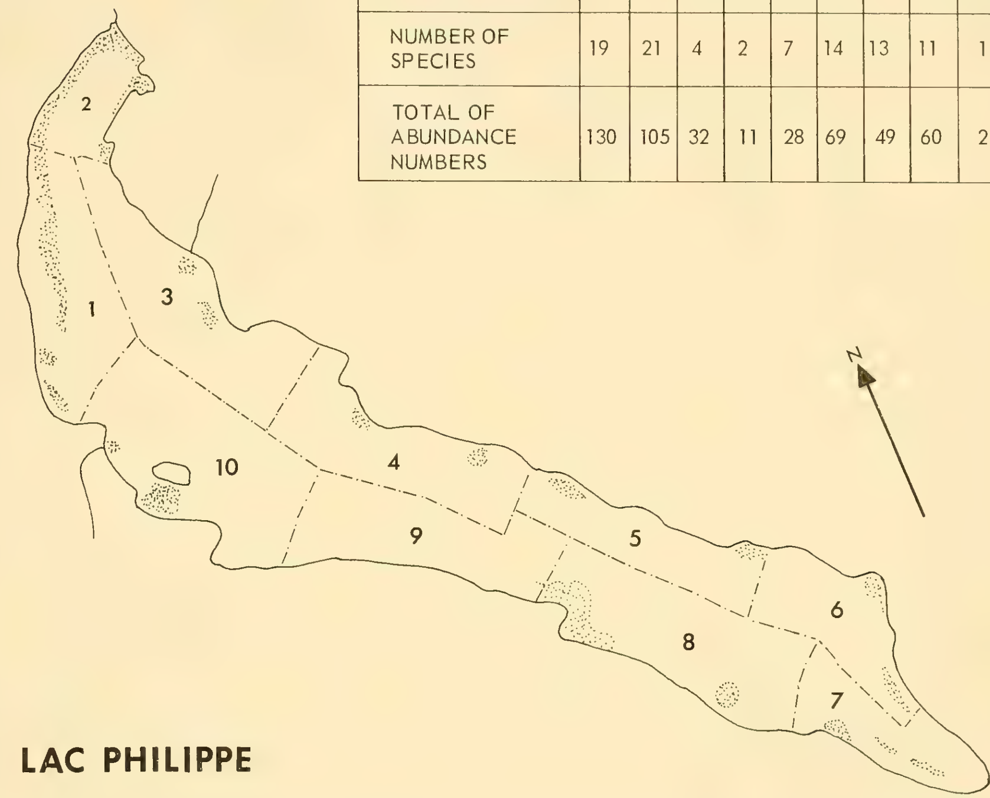


FIGURE 5. Map of Lac Philippe. Map is divided into 10 areas used in the study. Data from the surveys are summarized at the top of the figure.

shore of the lake has been altered by the dumping of sand to form beaches, but in many areas at the end of the sand there are large numbers of submersed aquatics. Sand is washing off the beaches and moving across the southern bay along the connecting stream, and is being deposited at the northern end of Harrington. Eleven species were found in the southern end of Lac Philippe but often only as isolated plants.

5. *Ramsay Lake*. Figure 6

Because the water is brown and silt settles on plants that grow close to the bottom, it was difficult to survey this lake for submersed aquatics. The species list given in Tables 1 and 2 was compiled after several visits. The unpublished data table, which gives the species composition and abundance in the numbered associations on the map, shows that certain species such as *Najas flexilis* and *Utricularia gibba* were found adjacent to the bog, while species such as *Potamogeton natans* and *Sagittaria latifolia* were found on the rocky and sandy shore opposite. *Pontederia cordata* was found in most associations but was only common in area 7. The yellow water lily, *Nuphar variegatum*, was the dominant species in areas 2 and 10; the white lily, *Nymphaea odorata*, was the dominant plant at the opposite end of the lake.

General Remarks

In many lakes the bays which are sheltered from the prevailing northwest wind have the greatest abundance of water plants, especially species with floating leaves. This is indicated in

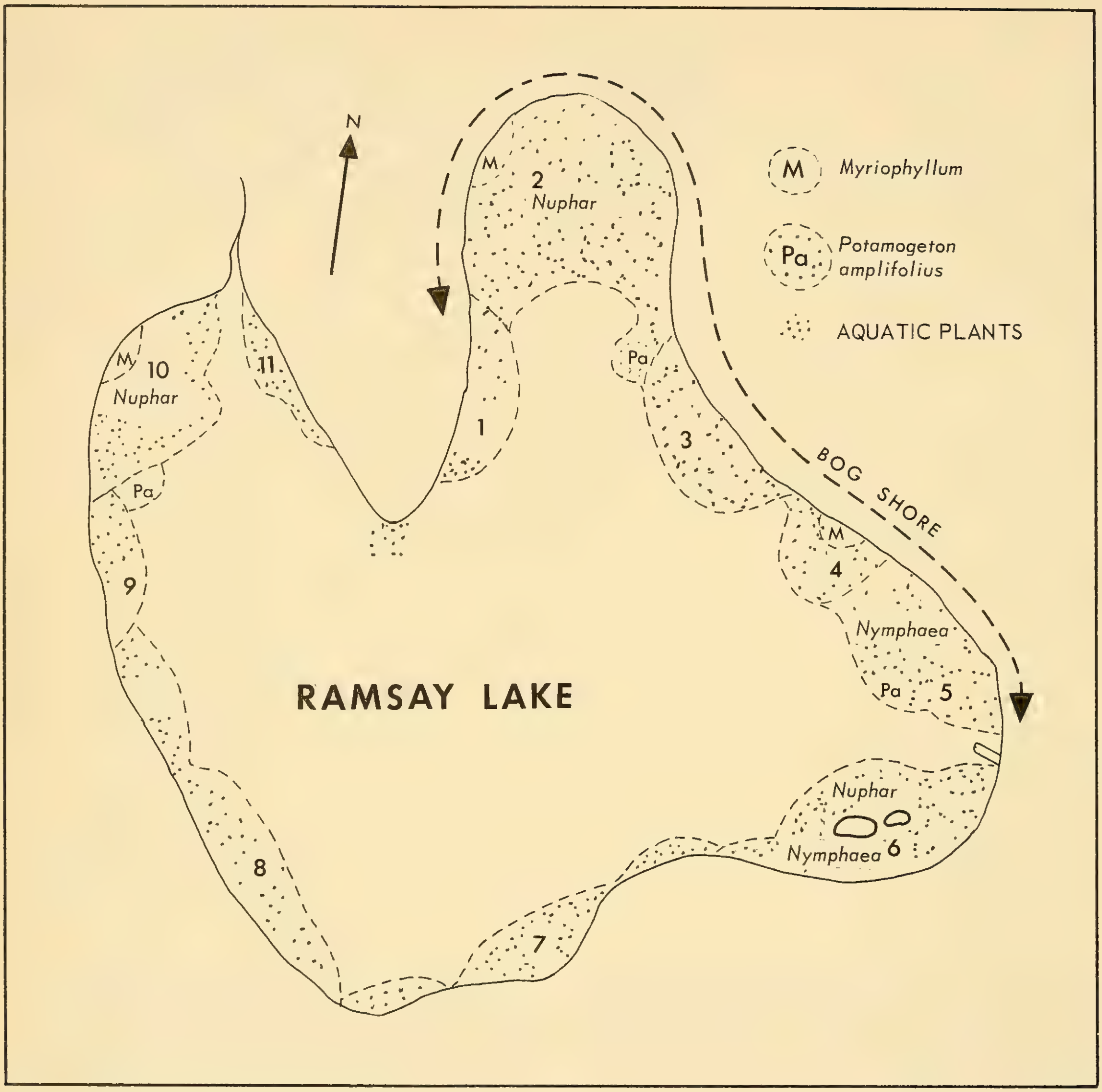


FIGURE 6. Map of Ramsay Lake. The numbers indicate the positions of the plant associations for which the species composition and the relative abundance of each species was recorded. (For details see Depository of Unpublished Data.)

maps of Meach, Philippe, and Ramsay (Figures 4–6) and further illustrated by Carmen, Brown, Lusk, Renaud, and Taylor Lakes (Figure 7), and by Lac Lapêche.

Potamogeton amplifolius Tuckerm. was found to be variable, both in morphological appearance and in the depth of water in which the plants grow. This species is the subject of an independent study (Small and Aiken, in preparation).

The number of species found in lakes having a similar elevation differed (Table 3). Among lakes associated with a particular watershed, however, those having the highest elevation contained fewer aquatic plant species. This was shown by four different watersheds: by Kidder (9 species), Ramsay (31), and Holly (32); by Kingsmere (13) and Mulvihill (15); by Brown (24) and Carmen (32); and by Mud (17), Taylor (29), Renaud (25),

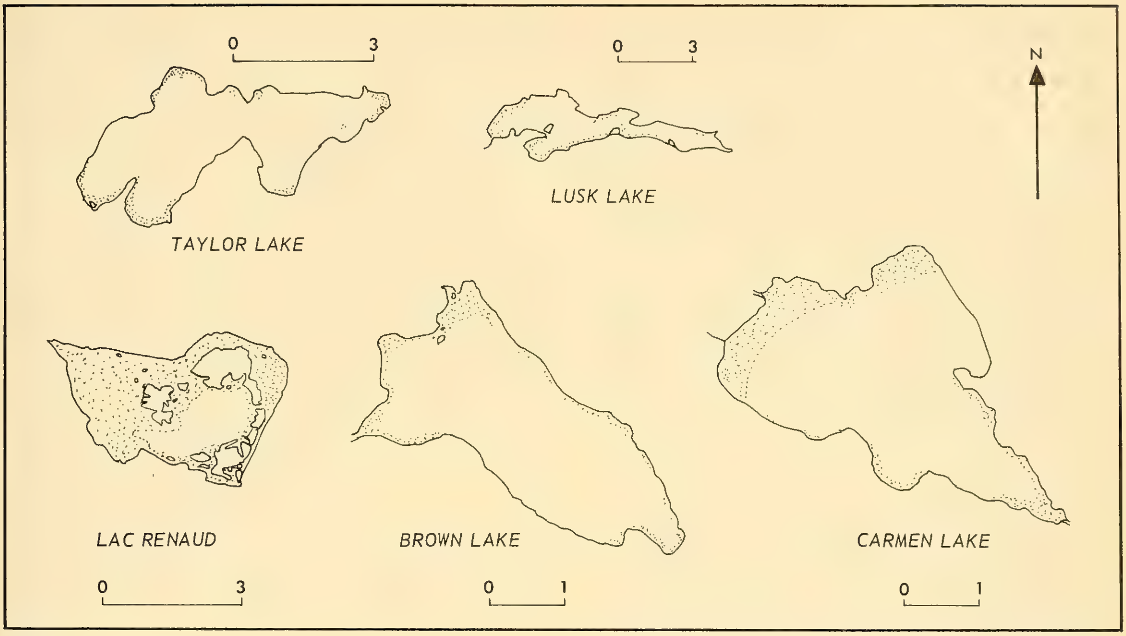


FIGURE 7. Maps of five lakes in Gatineau Park which have conspicuous quantities of water plants in northwestern bays. Shading indicates areas having dense aquatic vegetation.

Philippe (44), and Meach (51). A large difference in lake size modifies this generalization. Also the number of different habitats in a lake modifies the total number of species. Thus, Lac Renaud, which is smaller and has fewer habitats than Taylor Lake, had fewer species.

Discussion

How water plants reinvaded the lakes after glaciation is not known, but it is probable that the waters of the Champlain Sea were influential. Those lakes known to have been inundated by the Champlain Sea at approximately the same time (Carmen, Brown, Lapeĉhe, and Meach) had 32, 25, 52, and 51 species of aquatic plants, respectively. Lakes above the 700-foot level had significantly fewer species numbers: Kingsmere 13, Kelly 8, and Curley 15. More needs to be known about the exact limits of the Champlain Sea in the Park, but it is speculated that the large quantity of water plants found in Ramsay, Holly, and Renaud Lakes, and the relatively high species numbers (31, 32, 24, respectively) may also reflect the influence of the Sea. The elevations of these three lakes (Table 3) are all very close to the general figure of 650 feet considered by Gadd (1962) as the limit of the Champlain Sea.

The striking contrast in the amount of water plants found in Ramsay and Kidder Lakes may also be related to the level of the Champlain Sea in the area. Kidder Lake had a similar water chemistry to Ramsay (Casserly, J. Gatineau Park water chemistry survey. Limnological baseline study, Gatineau Park Lakes. National Capital Commission unpublished report (1971). pp. 24–42). They are about a mile apart and connected by a stream, but Kidder had only nine species and very small numbers of plants. The present water level may have been influenced at some previous time by a beaver dam and more recently by rock fill across the outlet stream. Kidder Lake, however, is 55 feet deep and an old lake, not a recent beaver pond. At 679 feet above sea-level it is higher than Ramsay and uninfluenced by the Champlain Sea.

The contrast in the numbers of plants in Ramsay and Kidder Lakes suggests that it is very difficult for plants to be transported upstream. Because the water warms up slowly in the spring, there is a relatively short growing season in the Park lakes. *Nuphar variegatum* Engelm., one of the first water plants to flower and fruit, has a widespread distribution. Some aquatic species in

Park lakes have not been observed to flower, and many have not produced mature seed before early September when the first frost can be expected. Some years there may be no mature seed of species available before the first frost, other years there is only a short period when accidental transfer of seed to higher altitude lakes could occur. The lower numbers of species in many of the more isolated lakes may reflect the fact that more species have not reached them.

How the accidental transfer of seed to high altitudes occurs is not known. Aquatic animals are active in many Gatineau Park lakes and may be partly responsible. Curley, Kidder, Mud, Lusk, and Black Lakes all have beaver dams, and all are isolated lakes at the top of watersheds. *Sparganium* species were found in all the above lakes, and in Curley, Mud, and Lusk Lakes, *Sparganium* was the dominant genus. The occurrence of species of this genus in these relatively high-altitude lakes suggests an aquatic animal transport.

Nymphaea odorata Ait. is the white water lily found in lakes in the central part of the park. It was not found in Kelly or Curley Lakes, which are isolated lakes near the western border, nor in any lakes east of Meach. But *N. tuberosa* Paine, which is common in the rivers of the Ottawa Valley, occurs opposite a summer residence near the outlet of Kingsmere Lake. The water lily was probably planted there, but in 1971 it had escaped to the inlet bay of Mulvihill Lake less than 100 yards away. Very probably *N. odorata* would grow in these lakes had it reached them. In 1972 *N. odorata* was introduced successfully into Pink Lake by Aiken.

Butomus umbellatus L. was introduced into Canada and has escaped into the Rideau and Ottawa Rivers where it is becoming a nuisance. One rootstock had been planted in a private garden beside Kingsmere Lake in 1971. Judged by its success in the Ottawa River, this plant could very easily escape from Kingsmere and could become widespread in the Park.

The Gatineau Park roadway runs adjacent to the shores of Black, Bourgeois, and Fortune Lakes, and the relatively high species numbers found in these lakes which have elevations of over 900 feet above sea-level may have resulted, in part, from man's influence.

Three lakes, Philippe, Harrington (Mousseau), and Meach, form a series in the valley of an ancient glacier. *Sparganium angustifolium* Michx. is the dominant aquatic in Harrington, the middle lake in the series, yet it did not occur in Philippe and had only a limited distribution in Meach Lake. Lusk Lake which drains through the Lusk Caves into Harrington, also had *S. angustifolium* as the dominant aquatic species.

Because the area of Gatineau Park is relatively small, 21 lakes so geographically close together might have been expected to be more uniform. The diversity found is attributed to the recent (11,600 B.P.) denuding of the area by the Wisconsin Glaciation, followed by the inundation of some, but not all of the lakes by the Champlain Sea. A total of 96 species of aquatic plants was found from all the lakes in the Park, but the highest species number found in any one lake was only 52. These figures are probably a reflection of the isolated positions of some lakes relative to others, the short growing season, and the limited accidental transfer of aquatic plant material to lakes of higher elevation.

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Recent Observations of the Gray Whale in British Columbia

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Abstract. Observations of gray whales along the British Columbia coast confirm the occurrence of a peak in spring migration there during the first half of April, and provide further evidence that the animals follow a near-shoreline route while both north- and south-bound, especially along Vancouver Island. At Wickaninnish Bay on the central west coast of Vancouver Island, gray whales have been seen regularly, apparently feeding, during each of nine summers 1965–1973 except 1967, and similar sightings have been made each month between October and February in both 1971–1972 and 1972–1973. Among the gray whales recorded have been two females with young, one pair of which summered at Wickaninnish Bay in 1969, a pair engaged in mating or erotic play, a young animal apparently feeding in protected inlet waters, and a naturally marked individual that appeared at Wickaninnish Bay in 1970, 1972, and 1973.

Introduction and Methods

In their definitive work on the gray whale (*Eschrichtius robustus*), Rice and Wolman (1971) have drawn largely from data obtained along California shores, near the southern end of the eastern Pacific population's range. Information from farther north, particularly that relating to aspects of migration and feeding, has been provided largely by Pike (1962) and Pike and MacAskie (1969). During recent years we have had frequent opportunity to observe gray whales along the central west coast of Vancouver Island and have gathered additional information from knowledgeable residents of that area. Our data, given below, supplement the picture of migration given by the authors cited above, and introduce some previously undocumented aspects of the occurrence of the gray whale along this lower central portion of its annual range.

Most observations were made incidental to other work. While carrying out an inventory survey of mammals in Pacific Rim National Park (Hatler 1972), the senior author observed whales both from shore and from a small boat at irregular intervals in 1971 and 1972, and obtained additional information from local crab fishermen who regularly worked in the main whale-watching areas. The junior author observed whales throughout the summer of 1972 while conducting guided sea-mammal observation tours for a private concessionaire in Pacific Rim Park, and prepared a gray whale bibliography and status report for the park during the following winter and spring (Darling 1973). Observation forms were provided to several lightstations along the west coast of Vancouver Island in 1972, and personnel at some of these provided records of migrating whales during winter and spring 1972–1973, as weather and opportunity permitted. Observations, again at irregular intervals, continued through September 1973.

We are confident that most observations reported here involved gray whales and not other species. All were made within 1 mile from shore and most were within 1/2 mile. Pike (1962) has shown that such near-shore sightings rarely involve species other than gray whales, a conclusion which our observations support but which we did not accept complacently. We actively looked for other species, but rarely saw them. At Wickaninnish Bay especially, approaches to 100 m or less of observed whales was the rule, and under such conditions we nearly always saw the series of humps or "knuckles" along the posterior dorsum which is characteristic of the gray whale. The crab fishermen who provided data are keen observers who are thoroughly familiar with this and other common species, and among our respondent lightkeepers, at least two indicated their competence by noting "identification not certain" for some sightings they recorded on our observation forms.

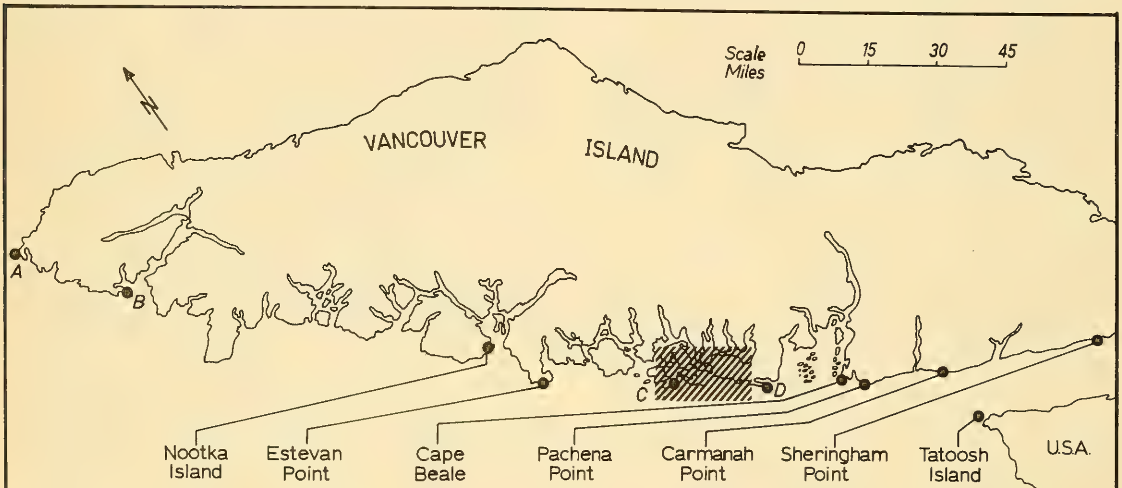
Results

Migration

Counts and direction of movement of passing gray whales, as recorded by lightkeepers along the west coast of Vancouver Island, are shown in

Figure 1. As Pike (1962) has suggested, the paucity of observations of southbound animals along the Vancouver Island coast in winter has probably been due largely to the inclement weather and subsequent poor visibility typical of that time of year. He had just three significant winter observations from this area and a few more from other British Columbia locations, but from these he inferred that gray whales pass British Columbia shores in December and January with a peak in late December. Pike and MacAskie (1969) provided additional records including sightings of small groups of gray whales passing Langara Island (northwest Queen Charlotte Islands) in October–December 1960, peaking in December, and a count of 22 moving south past Kains Island, northwest Vancouver Island (see Figure 1), in December 1962. Our lightstation records (Figure 1) also indicate a rather strong southward movement in December. Despite the fact that weather conditions made observations impossible on 10–15 days or more, whales were seen on 7 days of that month at both Cape Beale and Pachena Point. We emphasize that these counts are minimal as the light personnel were not spending long hours looking for whales, but were simply recording them when they saw them.

Information received from marine mammal biologists M. Bigg and I. MacAskie (personal communication) includes a lightkeeper's sighting of 12 to 15 gray whales moving south past Cape St. James (south Queen Charlotte Islands) be-



	Nootka Island	Estevan Point	Cape Beale	Pachena Point	Carmanah Point	Sheringham Point	Tatoosh Island
NOV	0	1-1-1 →	0	0	0	0	0
DEC	0	15-4-9 →	9-7-2 →	14-7-3 →	0	0	0
JAN	0	10-4-5 [a] →	0	0	0	0	0
FEB	0	0	← 2-2-1	[b] 11-4-5 ←	0	0	0
MAR	0	← 17-6-4	← 166-23-23	← 86-22-12	← "a few"[c]	0	← 40+[d]
APR	← 1-1-1	← 74-14-18	← 245-22-35	← 100-14-23	—	0	—

FIGURE 1. Observations, by Vancouver Island lightkeepers, of apparently migrating gray whales, November through April 1972–1973. Closed circles indicate locations of Department of Transport Lightstations, including four from which no data were obtained (A, Cape Scott; B, Kains Island; C, Lennard Island; D, Amphitrite Point), but which are mentioned in the text. The three numbers shown for any given month and location are, respectively, the total number of whales counted during the month, the number of days on which whales were counted, and the maximum number seen on any one day. The arrows beneath the sets of numbers indicate the direction observed whales were travelling (left=north; right=south). The cross-hatched area is that shown at larger scale in Figure 2.

Explantory footnotes, tabular data:

[a]One whale moving north, it and one southbound animal not positively identified as gray whales;

[b]Single gray whales seen moving south on 22 and 26 February;

[c]Those seen probably gray whales, but not positively identified;

[d]All seen during the period 1–3 March; no other reports received from this station.

tween 20 December 1972 and 3 January 1973, and an additional 10 (not positively identified) on 7–9 January. Bigg saw about a dozen southbound gray whales during a flight along the west coast of the Queen Charlotte Islands in December 1971, and in a flight on 9 January 1973, the junior author saw six gray whales moving slowly southeast in Wickaninnish Bay (see Figure 2). December observations at three of our respondent lightstations occurred on the following days (numbers seen each day shown in parentheses):

Estevan Point:
5th (1), 7th (4), 8th (9), 10th (1);

Cape Beale:
2nd (1), 4th (2), 6th (2), 7th (1), 10th (1), 13th (1), 14th (1), 31st (1 found dead);

Pachena Point:
3rd (2), 6th (3), 12th (1), 17th (4), 21st (2), 29th (2).

Thus, during winter 1972–1973, gray whales moved steadily by the British Columbia shores throughout a 5- to 6-week period including all of December and early January. This result is in general agreement with the winter movement pattern suggested by Pike and MacAskie (1969), although these authors' conclusion that there is a peak movement in late December now seems less certain. Weather conditions may have obscured either this peak during our observations or the strength of the early December movement during theirs. Future observers may find that southbound gray whales do not peak in local occurrence to the extent that they do while heading north in the spring.

Among the April lightstation records, 56 of 74 whales counted at Estevan Point, 98 of 100 at Pachena Point, and 210 of 245 at Cape Beale were seen by the 15th of the month. Thus, our records precisely corroborate those of Pike (1962), who wrote that northbound whales appear on the British Columbia coast in February and peak during the first two weeks of April. Pike and MacAskie (1969) have later indicated that there is relatively little movement by Vancouver Island shores in spring until late March.

Our observations from Estevan Point, Cape Beale, and Pachena Point (Figure 1) along with earlier records from Lennard Island, Amphitrite Point (Pike 1962), and Kains Island (Pike 1962; Pike and MacAskie 1969) indicate that numbers of whales do pass close to the Vancouver Island shore, along most of its length, during both north- and south-ward migrations. This is contrary to the views of Gilmore (1960, 1969) who postulated a more pelagic route across the Gulf of Alaska, which resulted in most southbound animals' bypassing Vancouver Island in the fall. He felt that the first landfall occurred at about the Columbia River. The additional records given above for the Queen Charlotte Islands suggest that Pike (1962) was correct in concluding that most whales pass from the north tip of Vancouver Island to the west side of the Queen Charlottes. But the paucity of records from the mainland coast along the east side of Hecate Strait at this latitude may be reflective more of an absence of interested observers rather than an absence of whales. H. D. Fisher (personal communication) saw three gray whales moving north in Higgins Passage at the mouth of Milbanke Sound, mainland coast (52° 20′ N, 128°30′ W), on 11 April 1973.

At the south end of Vancouver Island, the relative lack of information at Carmanah Point (as compared to that from Pachena Point just 18 miles north) and the complete absence of sightings at Sheringham Point (see Figure 1) may indicate that most whales leave (and arrive at) the Vancouver Island shoreline somewhere between Pachena and Carmanah and cross the Strait of Juan de Fuca to (or from) Cape Flattery on the Washington Coast. We are aware of a single record from east of Sheringham, that of Carl (1967) who reported that one animal apparently summered in inside waters near Victoria during 1967.

Occurrence in Summer

Rice and Wolman (1971) acknowledge that not all gray whales migrate to the Arctic in the summer, and list a number of scattered and irregular summer sightings at locations from southern California to the Queen Charlotte Islands. It is common local knowledge, but it has not been documented previously, that gray whales are seen regularly each summer in the immediate vicinity of Wickaninnish Bay, a shallow sand-bottom bay adjacent to Long Beach in what was formerly Wickaninnish Provincial Park and is now Pacific Rim National Park (see Figure 2). The first significant observations on this regular-

ity of occurrence were noted by provincial naturalists in reports on their summers in the area. Table 1 summarizes their information and that which we have gathered subsequently, providing coverage over nine summers from 1965 through 1973.

These data show that occurrence throughout the summer (roughly June through September) has been common, although a recurring feature (1965, 1966, 1973) has been a temporary scarity or absence in late July and August. Since most observations have been limited to Wickaninnish Bay, it is possible that these "absences" have been purely local. Gray whales have been seen, at times other than during migration, in Florencia Bay just south of the above area and in Schooner Cove, Cox Bay, and Ahous Bay (Vargas Island) to the north (see Figure 2). During the July period of apparent scarcity in 1973, gray whales were seen in Florencia Bay on at least one day (T. R. Bailey, personal communication). Another possibility is that these temporary disappearances and the nearly complete absence in summer 1967 have reflected changing feeding conditons in this area. The question of whether gray whales actually feed there is discussed later in this paper.

During the years of our observations, 1971–1973, the extent of our opportunity to record gray whale observations has varied considerably. In 1971 neither of us was present in the Wickaninnish Bay area after the April migration period until 1 August. On that date the senior author and park naturalist D. Foskett, conducting an aerial census of sea lions (*Eumetopias jubata*), counted four different gray whales between Sea Lion Rocks and the north end of Wickaninnish Bay. On 10 August and 26 September small-boat censuses of the same area by the senior author and an assistant, J. Biggar, yielded counts of five and three gray whales respectively. During this late summer period, sightings were common. Crab fisherman D. Arnet (personal communication) reported seeing as many as 10 whales (extent of duplication unknown) during a day's fishing on 13 September, but saw only two on 15 September. Vancouver Natural History Society members on charter boat tours near Sea Lion Rocks saw three, two, and three whales, respectively, on 18 and 26 September and 2 October (R. W. Campbell, personal communication), and Biggar saw four gray whales in Schooner Cove on 28 September.

TABLE 1 — Summer occurrence of gray whales in the vicinity of Wickaninnish Bay, Vancouver Island, British Columbia, 1965–1973

Year	Source	Remarks
1965	Buffam (1965)	Gray whales seen "virtually every day of the summer" but less commonly during the first three weeks of August than before or after this period
1966	Buffam (1966)	Seen until 15 July, but then disappeared and only one sighted from then through August
	Pike and MacAskie (1969)	One stranded in Florencia Bay in mid-August
1967	Campbell (1967)	Scarce all summer (19 June to 6 September), with only two sightings made: single whales on 24 June and 11 August
1968	Campbell (1968)	"At least six whales frequented Wickaninnish Bay the entire summer" (4 June through 2 September)
1969	Campbell (personal communication)	Gray whales again present throughout the summer
1970	Belton (1970)	Gray whales seen commonly during summer
1971	This study	Whales present at least through August and September (details in text)
1972	This study	Up to six or seven whales seen almost daily between 29 June and 4 September (details in text)
1973	This study	Apparently present throughout the summer but with temporary period of scarcity during last two weeks of July (details in text)

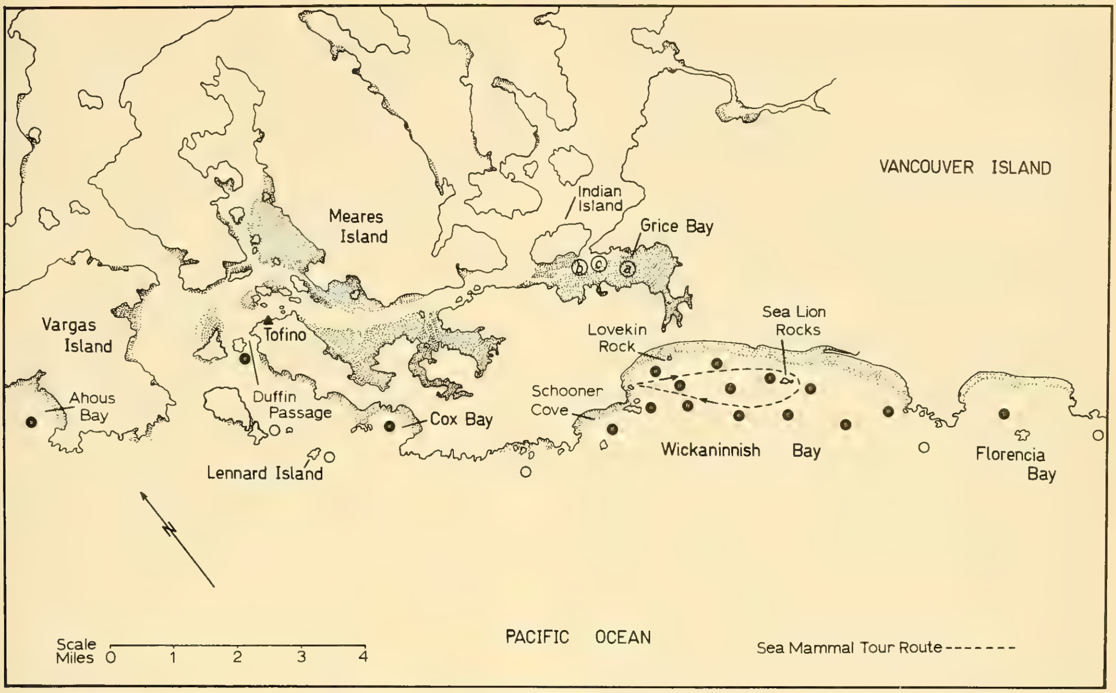


FIGURE 2. Observations of gray whales in the vicinity of Wickaninnish Bay, Vancouver Island, British Columbia, at times other than during migration. Closed circles represent approximate locations at which gray whales have been seen more than once, while open circles indicate single sightings. The three sightings in Grice Bay (labelled a, b, and c) were made on 27, 28, and 29 October 1971 respectively. Stippled areas indicate tidal mudflats (inside waters) and sand beaches (exposed waters). The entire area shown is indicated by a cross-hatched rectangle on Figure 1.

Our most intensive series of observations was recorded in summer 1972 when the junior author operated a commercial cruise boat for Pacific Rim Expeditions, Ltd. This firm's sea-mammal observation tours, run daily as weather permitted, covered an approximately 3-mile stretch of water between the north end of Wickaninnish Bay and Sea Lion Rocks (see Figure 2), and whales were seen only when they occurred on or near this route. From one to perhaps seven gray whales were seen each day of operation (29 June through 4 September) except on 14 and 24 August and 4 September. On these 3 days when no whales were seen, less than the full day of cruises was run owing to adverse weather conditions. The maximum count of six or seven (depending upon possible duplication) was obtained on 6 July; on 27 other days during which counts were possible numbers seen occurred in the following frequencies: one whale (5), two (2), three (8), four (5), five (6), six (1).

In 1973 our observations were again sporadic, but were sufficient to show that gray whales were present in the Wickaninnish Bay vicinity throughout the summer. Sightings of gray whales were a regular feature of nature walks conducted by park naturalists, and there were few days on which no whales were seen. The maximum count for any one time and place was seven, obtained by the junior author between north Wickaninnish Bay and Schooner Cove on 20 June. The apparent scarcity in late July, mentioned previously, was reported by the cruise-boat operators who were greatly disappointed at the fact, after having all but guaranteed visitors an opportunity to see whales. Sightings increased again in August, and the junior author counted four along the cruise route on 22 August and two just to the south on 4 September.

Among the summer observations, of particular interest have been sightings of apparent mother-young pairs. One cow and calf occupied

Wickaninnish Bay for most of the summer in 1969 (R. W. Campbell, personal communication). The senior author, on board a commercial cruise vessel near the north end of Wickaninnish Bay in July of that year, saw this pair but was unaware of the significance of the observation at the time, and more precise details were not recorded. There are apparently no published records of adults with young summering south of the Arctic feeding grounds, and even sightings during migration are exceedingly rare (Rice and Wolman 1971). We have one other probable record of a cow and calf gray whale: on an exploratory cruise with Pacific Rim Expeditions owner, J. Hudnall, on 29 June 1972, we were observing two feeding whales some 350 m northwest of Sea Lion Rocks (Figure 2) when a third suddenly blew just a few meters from the rocks and within 100 m of our boat. Attention was shifted to this third whale just as what appeared to be a very small whale surfaced and blew quickly, immediately beside it. Although it seemed evident that this was a mother-young pair, both disappeared seconds later and we were unable to find them again for confirmation. On 19 and 20 July a large and small gray whale pair, the two always side by side and blowing in unison, were seen at close range by the junior author and Hudnall. They were assumed to be a cow and calf, and may have been the pair glimpsed on 29 June.

Occurrence in Winter

Table 2 lists some of our gray whale observations between October and February in each of two winters (1971–1972 and 1972–1973). We have recorded whales at least once during each month of this period during both years, in partial confirmation of the remarks of longtime crab fisherman John Svoboda, Sr. (personal communication) who has told us that at least a few whales are always present. We stress that heavy surf, wind, fog, and rain are the rule at this time and on most days whales are not easily seen. We do not know where the whales weather out severe storms, but whales (presumably the same ones) may be seen in Wickaninnish Bay within a few days both before and after such storms, suggesting that they do not go far. During moderately rough weather, i.e., when observation is difficult but is still possible, whales may often be seen at the semi-protected north end of the bay, just north of Lovekin Rock (Figure 2).

Southbound migrants pass the Vancouver Island coast largely in December and perhaps early January, while some northbound animals appear

TABLE 2 — Observations of gray whales in the vicinity of Wickaninnish Bay, Vancouver Island, British Columbia, winters of 1971–1972 and 1972–1973

Date	Remarks[1] and Source[2]
27 Oct. 1971	At least one at north end of W. Bay[3] (dh)
5 Nov. 1971	At least three blowing near Lovekin Rock (dh)
15 Dec. 1971	One seen during sea-mammal census flight along Pacific Rim National Park shoreline, that in W. Bay (dh)
27 Dec. 1971	Independent reports from two crab fishermen that only one seen during day, that at south end of W. Bay (D. Arnet; J. Svoboda, Jr.)
13 Jan. 1972	One "feeding" among flock of sea ducks near Lovekin Rock (dh)
19 Jan. 1972	Two "feeding" 150–200 m out from Lovekin Rock (dh)
3 Feb. 1972	Four or five different animals seen in day's crab fishing at W. Bay (J. Svoboda, Jr.)
10 Mar. 1972	Two at Sea Lion Rocks and one north of W. Bay (D. Arnet)
24 Oct. 1972	Two in north half of W. Bay (dh)
1 Nov. 1972	One just south of Sea Lion Rocks (dh)
16 Nov. 1972	One "feeding" at north end of W. Bay (B. Campbell)
23 Nov. 1972	Two in north W. Bay; one behaving as though feeding (jd)
24 Nov. 1972	One apparently feeding in north W. Bay (jd)
2 Dec. 1972	Four in W. Bay near Sea Lion Rocks (J. Dyer)
7 Dec. 1972	One "breeched" twice in north W. Bay (jd)
11 Dec. 1972	Three near Sea Lion Rocks (J. Dyer)
13 Dec. 1972	Two at north W. Bay (jd)
14 Dec. 1972	Three apparently feeding near Sea Lion Rocks; observed at close range from a small boat for about one hour (jd)
28 Dec. 1972	One in north W. Bay (jd)
9 Jan. 1973	Two blowing at 3- to 4-minute intervals near Lovekin Rock; six moving slowly southeast just north of W. Bay (jd)
10 Jan. 1973	Several seen coming from the northwest into W. Bay (G. Trenholme)
6 Feb. 1973	Three near Sea Lion Rocks; diving pattern of two suggested feeding (jd)
7 Feb. 1973	One near Sea Lion Rocks (G. Trenholme)
23 Feb. 1973	One in south W. Bay blowing and diving in shallow water (B. Campbell)

[1]All observations by authors made on occasional visits to the area, as weather permitted.
[2]Source = observers. The initials dh and jd designate the senior author and junior author respectively.
[3]W. Bay = Wickaninnish Bay.

as early as February although they rarely show up in numbers until mid-March. This schedule would suggest that the vanguard of the northbound might meet the laggards of those moving south in our area, and it is difficult to determine the significance of our winter observations. As the remarks in Table 2 show, and as the discussion immediately following will indicate, we have seen gray whales apparently feeding in Wickaninnish Bay during January and February of two consecutive years, a time during which most of the population is supposed to be fasting in the warm waters off the coast of lower California (Rice and Wolman 1971). Since "feeding" animals have also been observed in the months preceding this period, it is tempting to speculate that some animals actually spend the winter at Wickaninnish Bay and do not make the full migration south. It would be necessary to have recognizably marked whales present in order to confirm this.

Feeding

Pike (1962) reviewed information on feeding and concluded that the gray whale "feeds little outside its arctic habitat." Gilmore (1969) stated flatly that gray whales do not feed on the southward migration, and Rice and Wolman (1971) support his statement for California shores with their analyses of 180 stomachs, none of which contained food. The stomachs of all but two of the 136 northbound whales examined by these authors were also empty, as were the stomachs of 10 animals taken in April off northwestern Vancouver Island (Pike 1962), although there were some intestinal contents in the Vancouver Island specimens, and Pike noted that these animals had "probably done some feeding." Later, reporting an observation of whales apparently feeding in Wickaninnish Bay in April, Pike and MacAskie (1969) generalized that some northbound animals do stop to rest or feed in British Columbia waters. More recently, three gray whales observed at Rose Spit, Queen Charlotte Islands, on 11 April 1973 were causing "upwellings of sand and mud from the bottom," i.e., perhaps feeding (H. D. Fisher, personal communication). Whether or not gray whales feed while migrating, it seems evident that those animals known to have spent all or much of the summer well south of the Arctic (including those listed by Rice and Wolman (1971) and those reported in this paper) must have sustained themselves by feeding locally.

Though there have been no whales collected in Wickaninnish Bay, thus making it impossible for us to demonstrate that they actually have food in their stomachs, we nevertheless are almost certain that they are feeding there, possibly throughout the year. Most of our summer observations, and many from other times of year, involve animals in water ranging in depth from about 5 to 15 m, and engaged in the following activity. Characteristically, a long dive of 2 to 3 minutes is followed by a series of short blows, usually three, the first of which is accompanied by the release of a brownish stain into the water (presumably waste material from the baleen). Following these short emergences, the animal arches forward in another deep dive, and during this motion it exposes most of its dorsal surface, although the flukes rarely appear. Whales engaged in this activity often worked back and forth through the same small area for long periods of time and the junior author, while piloting the cruise boat in 1972, noted that these could be encountered in the same general area on successive trips throughout one day.

Among our October–February observations, a number involved animals engaged in the above activity, our description of which matches the "feeding behavior" described by Wilke and Fiscus (1961). These authors have observed "seabirds" settling into the brown muddy patches produced by surfacing whales, implying that organic matter is included in the material released; we have seen gulls do the same at Wickaninnish Bay, and have noticed that "feeding" whales are often accompanied by sea ducks. On 19 January 1972, the senior author watched two whales apparently feeding near Lovekin Rock for over 1 hour. During this time two bunches of scoters (*Melanitta perspicillata* and *M. deglandi*) had divided from one large raft and each was following a whale. The whales moved back and forth over an area of less than 150 m^2 during the period of observation, changing direction frequently, and each group of ducks (most members of which were diving regularly and apparently feeding) maintained orientation with its respective whale. It was evident that either the scoters and the whales were exploiting a common food source or that the scoters were opportunistically snatching organisms stirred up by the whales.

In considering the rather well-documented concept that migrating gray whales do not feed, we are left with three alternative explanations for our observations. (1) The whales of our observations are not actually feeding. As indicated, we believe that they are; they at least appear to be trying. (2) These whales are not migrating. Because we have not been working with individually marked whales, there is little evidence either for or against this alternative and the question must be deferred at this time. Comments on one recognizable whale will be presented later. (3) Some or all migrating whales feed in suitable habitats along the migratory route, but there are few such areas south of the Arctic and perhaps none of significance south of Vancouver Island. This alternative seems reasonable and would explain the absence of food in the digestive tracts of animals off the California coast, where many of the absolutes of gray whale biology have been established.

Occurrence in Protected Waters

Gray whales occasionally enter the more protected waters of Clayoquot Sound, 10 miles north of Wickaninnish Bay (Figure 2). On 30 April 1969 the senior author observed one in Duffin Passage near the mouth of Tofino Harbour. The late R. Folker (personal communication) had seen gray whales "rubbing themselves" on a gravel bar at that location several times in the past. The most extreme inland record we are aware of occurred in October 1971. A Tofino resident had reported seeing a whale blow in Grice Bay (8 miles or more inland from Tofino; see Figure 2) on about 20 October, but had acknowledged that he had seen it at some distance and that it could have been a killer whale (*Orcinus orca*). This would not have been an unusual sighting, and the report was not followed up.

On 27 October, the senior author visited the area to carry out other biological duties and found a gray whale in 3–4 m of water in this mud-bottom bay. The animal was approached in a small boat to within 30 m to confirm identification, and was then watched for several minutes. It was a small animal, no more than 9 m in length, and it was apparently feeding. This whale was still present on both 28 and 29 October, but was working the deeper waters (6–10 m) near Indian Island on those days (locations plotted in Figure 2). Duties elsewhere made further observation of this animal impossible, and we do not know when it left Grice Bay. The earlier report from the Tofino resident suggests that it may have been present there for 10 days or more.

Possible Mating

On 26 April 1971, the senior author was attracted to a disturbance in the water about 1/2 mile offshore at the north end of Wickaninnish Bay. Through a 20-power telescope set up on a nearby knoll, he obtained a clear view of two gray whales engaged in vigorous activity. At least one of the animals frequently rolled over on its back with its flippers protruding from the water. There was much rolling and sounding, the latter frequently occurring with the flukes coming high out of the water and slapping the water surface with a large splash. Once both animals sounded, both sets of flukes showing at once and disappearing together.

Most often only one animal showed at the surface except when they were moving. Then one followed the other, both close to the surface and blowing often. These straight-line movements were usually only 50–75 m, at which time the trailing animal (perhaps the female judging from the observations of others (e.g., Sauer 1963)) initiated activity by speeding up, sounding, and coming up beneath the other. Frequently this started a series of rolls. On several occasions the male's conspicuously pink, erect penis showed clearly as the animal rolled over on the surface. Once the other animal's head emerged from the water and nudged the penis. Heads were seen frequently, but always only one at a time. These two whales maintained nearly continuous activity from 15:05 to 16:35 Pacific Standard Time. Observation was continued until 17:20, by which time no further activity had occurred. There were then five whales in the area, all apparently feeding, and there was no obvious pair among these, thus it was not evident which had been the original two. It was not possible to determine whether copulation had actually occurred, but the erotic nature of the activity was evident.

Rice and Wolman (1971) have provided sufficient histological evidence that reproductively functional breeding occurs before the spring migration. But they cite other records of apparent mating activity in northern areas, including ob-

servations from northern California, Washington, and northern Alaska. It may be that erotic play, and perhaps copulation, is a common recreational pursuit in this species.

A Naturally Marked Whale

Hubbs (1959) has called attention to conspicuous whitish patches, constituted by groups of epizoites and/or scars, which develop on the skin of gray whales. During the 1972 daily summer cruises at Wickaninnish Bay, the junior author was subjectively certain that he recognized some individuals repeatedly on the basis of these markings, but such information is difficult to document. One whale, however, was easily recognizable and we have obtained photographic proof that this animal has appeared in Wickaninnish Bay on more than one occasion (or perhaps over a long period of time). This whale possessed a large, rounded and distinctly orange-colored scar on its left side just below the "knuckles" on the lower back.

Figure 3 shows two views of this whale. The first photograph (A) was obtained by the senior author when the animal was first seen in October 1970. At this time it was "feeding" in company with two others near Sea Lion Rocks in Wickaninnish Bay. Without knowing that this photograph had been taken, the junior author first noted seeing this animal on 20 August 1972, recognizing it as one he had seen several weeks previously. We compared notes the following winter, and determined to watch closely for this whale. It appeared again during the summer of 1973, and Darling obtained the photograph of Figure 3B on 12 July.

The whale with the orange scar was seen again on 12, 18, and 20 August by cruise boat operator A. Oliver (personal communication), who had accompanied Darling when the animal was photographed on 12 July; on 22 August Darling obtained a third photograph of this animal. It was last seen during that summer on 2 September, by Oliver.

Thus, it is evident that at least one gray whale has been faithful to the Wickaninnish Bay area, returning to it in at least three of four summers between 1970 and 1973 and conceivably even residing there the year round during that time. Observation effort has been sporadic enough, especially during the winter months, that it could easily have been missed most of the time. In addition, as mentioned earlier, gray whales have been seen "feeding" in other areas within 10 or 12 miles of Wickaninnish Bay; if the naturally marked whale had occupied any of these areas, we probably would not have seen it, owing to our concentration of activities at Wickaninnish.

Another whale with a large white patch on its upper right side just below the rudimentary dorsal fin was photographed in Wickaninnish Bay on 14 December 1972. A photograph taken near Sea Lion Rocks on 22 August 1973 appears to portray this same animal, but we cannot generate the certainty, in this case, that is possible with the orange-scarred individual. The photos in Figure 3 have been reproduced from color transparencies; duplicate transparencies of these, of the 22 August (third) photo of the orange-scarred whale, and of the two photos of the white-scarred whale have been placed on file (PDF Number 320) at the British Columbia Provincial Museum, Victoria, British Columbia and are available for loan. Interested persons should write to Assistant Curator of Birds and Mammals, R. W. Campbell, at that institution.

Discussion

The annual migration route of the gray whale covers a distance, one way, of over 4500 miles (Pike 1962). Along this route, studies have been concentrated chiefly within the southernmost 500 miles, with occasional observations providing at least moderate knowledge of the species' occurrence as far north as Vancouver Island (about 1500–1700 miles north of the breeding area). As results reported in this paper indicate, our knowledge even at this latitude is fragmentary. Little is actually known of the species over the remaining (northern) two-thirds of its annual range, and many of the assumptions about its occurrence there (chief among which seems to be that it does nothing over most of this distance except swim) may be unwarranted.

We have found that gray whales may be seen, apparently feeding, during all months of the year at Wickaninnish Bay, Vancouver Island, British Columbia. This fact is somewhat at variance with previously published work, which has established that *most* members of the eastern Pacific population annually migrate between arctic waters where virtually all annual feeding is done, and lower California breeding grounds. If Wickanin-

FIGURE 3. A recognizably marked whale seen repeatedly in the Wickaninnish Bay area. (A) Photograph obtained when animal first seen, in October 1970. (B) The same whale, photographed on 12 July 1973.

nish Bay is the only area south of the Arctic which is occupied in the manner we have described, then our observations are of little consequence. But if small "pockets" of habitat between southern Vancouver Island and Alaska are regularly occupied by whales in this way, then it will be important to learn the nature of this occurrence. For instance, if it were found that certain classes of whales, such as first-year animals or non-breeders of one or both sexes, often do not make the complete migration to the breeding grounds, then the very sophisticated data on population dynamics obtained by Rice and Wolman (1971) could be badly biased. Having said this, we hasten to point out that we have no evidence that this is so; our data are sufficient only to suggest that further evidence may be required to demonstrate that it is not.

Perhaps the eastern Pacific population, having recovered from severe overexploitation relatively recently (Rice and Wolman 1971), is only now in the process of recolonizing feeding areas used previously. Perhaps the paucity of sightings outside migration periods has been due largely to an absence of observers. We received an unconfirmed report of four gray whales feeding near Nootka Island, 65 miles north of Wickaninnish Bay, in August 1973, and Pike and MacAskie (1969) report that "several gray whales [were seen] in late August and early September" along

the northern Queen Charlotte Islands. Both of these areas are more accessible than many others one might name between Wickaninnish Bay and arctic Alaska, yet neither is regularly frequented by potentially reporting observers; therefore regular occurrence, if it occurs, could easily go undetected.

Clearly our own data, obtained incidentally and sporadically, are deficient. We know only that gray whales occur regularly in Wickaninnish Bay. We do not know certainly that the same whales occur throughout the summer. If as we suspect, some do, how far do they range? We do not know the extent of local turn-over, if any, during migration nor the extent, if at all, to which migrating whales feed in the area. What food organisms are available in Wickaninnish Bay? The sex, age, and condition of most whales frequenting the bay has been largely unknown. Are whales seen in January and February in Wickaninnish Bay among those seen the previous (or following) summer, or are they others which do not complete the southward migration, or are they successive sets of migrants all of which eventually pass by? What is the migration route north of Vancouver Island? Is Wickaninnish Bay the only regularly frequented feeding (resting, staging) area south of the Arctic? An important function of this paper is to suggest that though the answers to all of these questions are presently unknown, perhaps none are unknowable.

Acknowledgments

For providing records of sightings, we are grateful to lightkeepers F. Bergthorson, G. Britton, J. Bruton, O. Edwards, E. Kidder, G. Swaney, P. Thomson, and D. Weeden; crab fishermen D. Arnet, J. Svoboda, J. Svoboda, Jr., and G. Trenholme; Pacific Rim Park Staff, especially F. Bamber, B. Campbell, and D. Foskett; and numerous other whale-watchers including J. Biggar, J. Dyer, and A. Oliver. Special thanks are due J. Hudnall for transportation to Sea Lion Rocks on many occasions, to R. W. Campbell, H. D. Fisher, M. A. Bigg, and I. B. MacAskie for their generosity in sharing their special knowledge of gray whales along the British Columbia coast, and to Fisher and Ian McTaggart Cowan for reading and commenting on an earlier draft of the manuscript. Dr. Cowan also supported a substantial part of the cost of publication from his NRCC grants, and for this we are truly grateful. Finally, thanks to typist Rose Cella, and to Pearse Bowden Economic Consultants for loaning us her services.

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Addendum

In late spring, 1974, the naturally marked (orange-scarred) whale reappeared in Wickaninnish Bay and reportedly stayed there throughout the summer. It was again photographed twice by Darling, on 19 May and 30 July.

A Preliminary Account of Gray Seals and Harbor Seals at Saint-Pierre and Miquelon[1]

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Ling J. K., C. E. Button, and B. A. Ebsary. 1974. A preliminary account of gray seals and harbor seals at Saint-Pierre and Miquelon. Canadian Field-Naturalist 88: 461–468.

Abstract. The gray seal, *Halichoerus grypus*, is the only species of seal previously reported from Saint-Pierre and Miquelon, whereas this study confirms that harbor seals, *Phoca vitulina concolor*, also haul out on sand banks in the Grand Barachois, Miquelon, and are believed to pup there from late May to early June. Up to 500 seals of both species (estimated at 75% harbor seals) were present on 5 June 1970, but numbers declined to about 100 by 3 September. Maximum haul-out seems to coincide with low tide up to mid-July and the seals are widely dispersed. Later on, haul-out bears no relationship to low tide and the seals are more closely aggregated. Such aggregations may be related to the need to maintain high skin temperatures in order to effect the annual molt in August, since bunching is also correlated with ambient temperatures.

Introduction

There are three breeding populations of the gray seal, *Halichoerus grypus* (Fabricius): one in the Baltic Sea, another in the eastern Atlantic from the British Isles (and occasionally France) to the White Sea, and a third in the western Atlantic from Newfoundland to Massachusetts (Rice and Scheffer 1968). The western Atlantic population, numbering about 15,000 seals, breeds chiefly on several islands in the Maritimes and disperses to other islands in eastern Canadian waters (Mansfield 1966; Fisheries Research Board of Canada 1973). One of these dispersal areas is in the French Territory of Saint-Pierre and Miquelon off the southern tip of Newfoundland, where a colony of gray seals has been reported to haul out during the summer months.

As far as the authors are aware, there have been no reports in the literature to date of harbor seals, *Phoca vilulina concolor* (De Kay), at Saint-Pierre and Miquelon. Until the present time it had been assumed that the seal colony there consisted entirely of gray seals. The observations reported in this paper demonstrate that not only do harbor seals comprise about 75% of the pinniped population in the island territory, but they also probably breed on Miquelon.

Mansfield (1966, 1967) has given general accounts of *H. grypus* in eastern Canadian waters. He stated (1967) that more than 1,000 gray seals haul out on Miquelon from March until November. These seals were believed to be mainly young-of-the-year dispersing from the breeding grounds and immature animals, but accurate classified censuses have not been carried out. Cameron (1967, 1969, 1970, 1971) has made extensive studies of gray seals on the Basque Islands, Nova Scotia during the winter breeding season and summer months.

Seals are protected by law in the French Territory, so that they are relatively undisturbed at the study area. It is hoped, therefore, that this will provide basic data pertaining to a reasonably natural situation which may be relevant to other localities, where human factors are more pronounced.

Description of the Area

The French Territory of Saint-Pierre and Miquelon consists of an archipelago of several small islands and islets some 20 km from the southern tip of the Burin Peninsula of Newfoundland (Figure 1). There are three main islands: Saint-Pierre, Langlade, and Miquelon. A narrow isthmus has formed only in the last 200 years to join Langlade and Miquelon, which lie about 10 km apart (Rannie 1968). The principal study area at present is centered on a series of sand banks which are exposed at low tide in the Grand Barachois at the southern end of Miquelon.

The Grand Barachois (Figure 2) is roughly the shape of an equilateral triangle with sides 4.25 km in length consisting of low-lying sand dunes and grassy flats. It opens to the sea at the southeastern corner through a narrow entrance, the Goulet de

[1]Studies in Biology from Memorial University, Number 286, contribution Number 15 from the Centre for Environmental Biology.

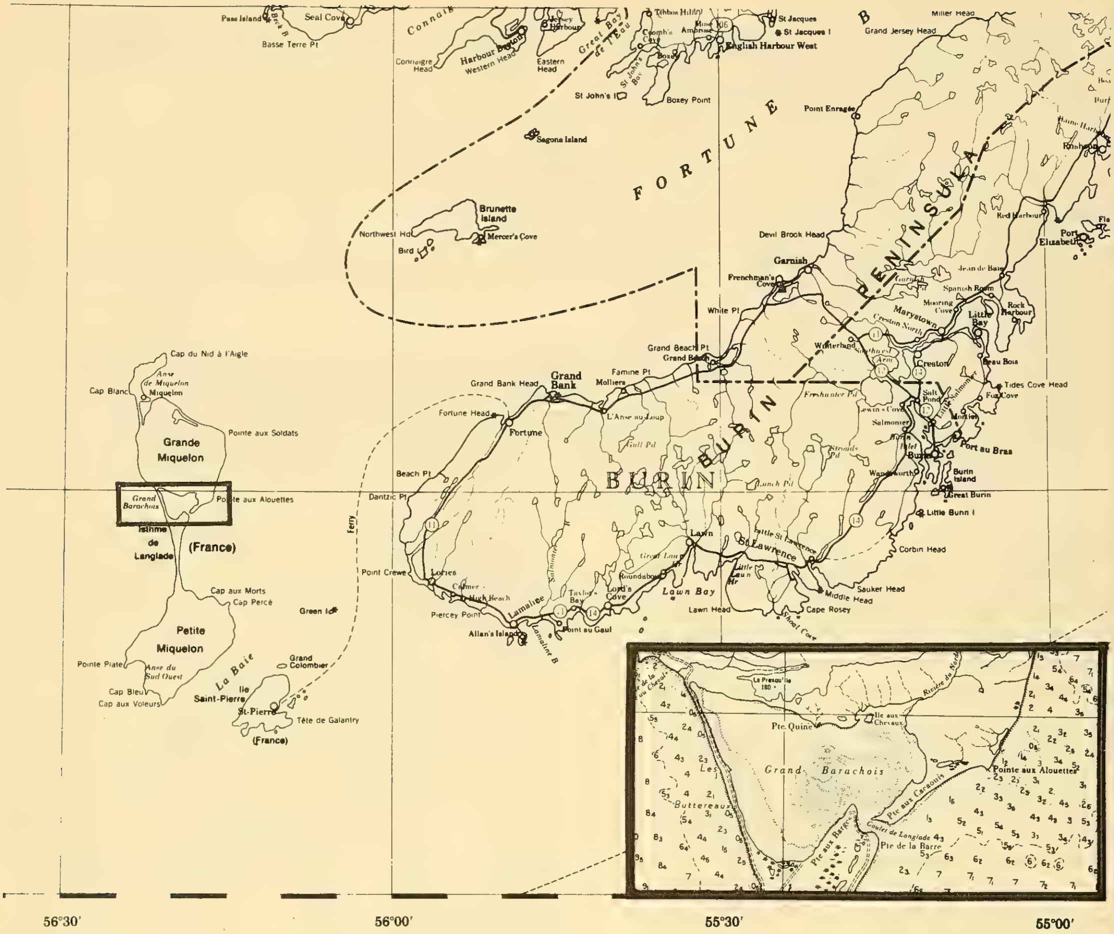

FIGURE 1. Locality map of Burin Peninsula, Newfoundland, and Saint-Pierre and Miquelon showing places mentioned in the text. Inset: The Grand Barachois.

Langlade. At spring high tide all of the sand banks are covered by water at least 0.3 mile depth, while at spring low tide extensive areas of sand are exposed. The water attains a depth of only 1 to 3 m over most of the Barachois, but many of the channels scoured by tidal action around and between the sand banks may be 5 to 7 m in depth. Maximum spring tidal fluctuations measure approximately 1.25 m and are not as great as those in the outside ocean. The shoreline consists of clean sandy or pebbly beaches cut by numerous small streams arising from marshy areas inland and flowing into the Barachois, the salinity of which, however, is only slightly less than that of the ocean. The waters become very turbid after heavy rain, owing to the large amounts of silt eroded from the surrounding land.

The dominant aquatic vegetation consists of *Zostera sp.;* invertebrate fauna, the edible mussel, *Mytilus edulis* and soft-shell clam, *Mya arenaria*; and fish fauna, long-horn sculpin, *Myxocephalus octodecemspinosus* and short-horn sculpin, *M. scorpius*.

Itinerary and Methods

Five visits were paid to the Grand Barachois from 5 June to 3 September 1970. One of us (JKL) flew over the study area for about half an hour in the afternoon of 5 June at heights ranging about 600 to 100 m. The other four visits were by sea to Langlade or Miquelon from Saint-Pierre and overland by jeep to the Grand Barachois. The first of these four visits was still in the nature of a reconnaissance and lasted only 2 days from 10–12

FIGURE 2. Aerial view of the Grand Barachois looking west and showing localities mentioned in the text and main seal haul-out areas (X).

June when all three authors were at the study area. The other three study periods were 27 June to 16 July, 19 July to 6 August, and 28 August to 3 September, when only two of the authors (CEB and BAE) visited the area. Observations were carried out on land and by boat.

The base camp for the study area was set up in one of a group of huts erected at Pointe aux Barges by the Government of the Territory for the use of fishermen. These huts overlook the Grand Barachois and are situated approximately 600 m from where most of the seals hauled out. One hut provided a convenient observation post for use in inclement weather. Observers occasionally crossed the Barachois by rubber raft to Pointe aux Cacouis, where sightings could be made from an elevation of about 7 m above sea-level and somewhat closer to the seals than at Pointe aux Barges.

In addition to detailed studies at the Grand Barachois, a watch for seals was kept during all travel by jeep or boat on and among the islands of the archipelago. Occasional sightings were made at different locations. Local knowledge of seals in the island territory was sought, to be followed up by actual inspections in the event of any reports of major significance.

Owing to the extreme wariness of the seals and a complete lack of cover in close proximity to them in the study area, most detailed observations were made either from Pointe aux Barges or Pointe aux Cacouis. Casual observations were made while we were walking along the shore, particularly near the Goulet and in the vicinity of the huts as the seals swam by or stayed to observe the observers. Studies of behavior of the seals were made from a boat or raft crossing the Barachois.

For detailed studies from Pointe aux Barges or Pointe aux Cacouis, Tasco 7 × 50 binoculars with yellow filters and a Rodenstein 20× to 60× zoom telescope mounted on a tripod were used. Compass bearings on seal aggregations were taken using a theodolite from both of these stations during all observations for plotting purposes later and to give angles of arc occupied by seal groups.

The following data were recorded at approximately two-hourly intervals during daylight over each of the study visits:

1. date,
2. time,
3. tide (high, low, ebbing, or flowing),
4. cloud cover,
5. wind speed (according to the Beaufort scale),
6. air temperature,
7. total number of seals hauled out (classified, if possible, according to species, sex, and age),
8. compass bearings of extreme edges of each major seal aggregation (to give angle of arc),
9. behavior of seals (not considered further in this report).

Results

(a) Observations

Since it was rarely possible to identify the species of all seals in the haul-out groups because of the great working distances, the data refer to both species together.

Many sightings were made, in transit from the road between Miquelon Township and the Grand Barachois, of seals swimming in the ocean along the western side of the island. A few seals were also seen from a boat en route to Sainte-Pierre off Point aux Soldats on the east side of Miquelon. Once too, while we were travelling by boat between Fortune, Newfoundland and Sainte-Pierre, a possible sighting of three seals on la Petite Île Verte was made in the gathering dusk. Up to the present time we have had no reports on seals at other localities in the Territory. The principal haul-out area undoubtedly is the large sand banks which are exposed at low tide within the Grand Barachois on the island of Miquelon.

During the aerial reconnaissance three groups of seals were seen hauled out on the sand bank (Figure 3) and there were many more seen swimming in the clear shallow water. Numerous pairs of seals, each comprising a small and large animal, were seen in the water and on the sand bank. The species of seals were not identified positively, but were suspected to be harbor seal cows with pups, on the basis of locality and known pupping dates (Bigg 1969).

A landing by boat on the exposed sand bank in the Barachois was made on 11 June. The seals

FIGURE 3. Aerial view of 310 seals hauled out on a sand bank in the Grand Barachois, 5 June 1970.

quickly took to the water, but an immature male harbor seal was found dead on the sand. This again suggested that the pairs of large and small seals might be harbor seal cows with pups. Confirmation that the Grand Barachois was indeed inhabited by harbor seals came in August when Mr. Brian Beck of the Fisheries Research Board of Canada collected three gray seals and five harbor seals. He estimated that the population at the time consisted of about 75% *Phoca vitulina* and 25% *Halichoerus grypus*.

The maximum daily total numbers of seals observed over the study period are shown in Figure 4. A sharp decline in numbers on 4 July is attributable to human disturbance when boats entered the study area and the seals took to the water. On the occasion of the reconnaissance flight over the Barachois on 5 June it was estimated that 50 to 100 pairs of seals (consisting of a large and small animal) were in the water, and 310 seals were counted on an aerial photograph (Figure 3), making the total number of seals in the area between 410 and 510 on that day. The validity of using total counts of seals hauled out as a measure of abundance is therefore questionable in view of the unknown number of seals in the water at any time and not visible from the land counting-stations. In the absence of other data, however, these figures must be used for any further discussion. The number of seals hauling out in the Barachois remained between 300 and 350 until 6 August, after which date counts declined steadily to about 100 one month later. The figures shown from 12–14 August were provided by Mr. Brian Beck of the Fisheries Research Board of Canada during a seal collecting trip to the Grand Barachois. Seals had already been disturbed by rifle fire prior to these dates, but the three daily censuses were carried out early in the day before shooting started.

Dispersion of seals as measured by the angles of arc or spread of the aggregations along the edges of the sand banks during maximum daily haul-out is shown in Figure 5. There was a noticeable decrease in the dispersion arc after 9 July, in spite of seal numbers, remaining relatively constant for almost another month. Seals tended to bunch together more closely after 9 July, and formed a single group, replacing the two or three loose aggregations observed before this date.

The times of low tide and maximum daily haul-out number are plotted in Figure 6. A fairly close correspondence between the two times is obvious up to July 16, but after this date times of haul-out and low tide do not coincide.

(b) Analysis of Data

The raw data were analyzed in an attempt to find possible relationships between haul-out behavior and a number of environmental factors. Observations on days when seals were disturbed have been excluded from further analysis. A multiple regression analysis (Kelly et al. 1969) and a correlation matrix indicated the statistical relationships between haul-out behavior and the recorded physical variables (cloud cover, wind velocity, tide, air temperature).

Correlations between the number of seals hauled out and cloud cover and wind velocity were insignificant; i.e., cloud cover and wind did not appear to influence the number of seals hauled out.

The time of maximum haul-out and low tide were significantly correlated $r_{xy} = 0.774$; $P < 0.0001$) throughout the summer observation period. There were differences, however, between the degree of correlation in early ($r_{xy} = 0.972$; $P < 0.0001$) and late summer ($r_{xy} = 0.283$; $P < 0.05$) which were again significant ($r^2 = 7.16$; $P < 0.01$). Before 13 July haul-out was associated only with low tide; after that date maximum haul-out occurred up to and even during high tide.

There was a strong negative correlation between air temperature and the number of seals hauled out between 10 June and 12 July ($r_{xy} = -9.580$; $P < 0.001$). In the latter part of the summer, however, haul-out numbers were just as positively correlated with ambient temperatures ($r_{xy} = 0.614$; $P < 0.001$). Air temperatures could also predict, or significantly account for, the variability of seal numbers in both early ($F = 17.000$; $P < 0.001$) and late summer ($F = 22.356$; $P < 0.0001$).

In addition to the number of seals hauled out being apparently related to air temperature, their dispersion (measured by the angle of spread) also was influenced by this factor. There was a strong negative correlation between the air temperature and dispersion of seals ($r_{xy} = -0.583$; $P < 0.001$); i.e., air temperature reliably predicted the dispersion arc covered by the seal aggregations ($F = 19.0055$; $P < 0.0001$). As summer temperatures rose, the animals were spread over a narrower arc, despite numbers remaining relatively high. Re-

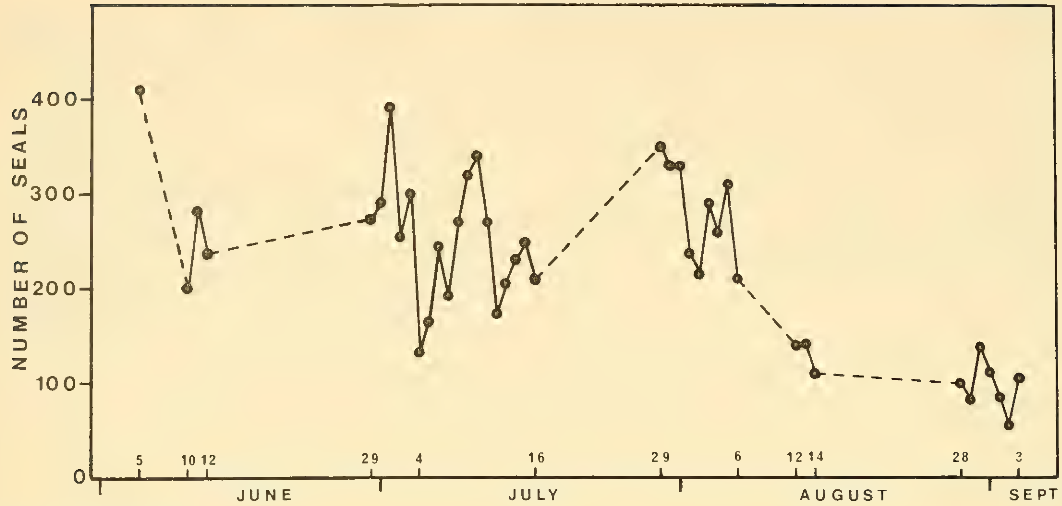

FIGURE 4. Daily maximum counts of seals at the Grand Barachois, Miquelon, for the period 5 June to 3 September 1970.

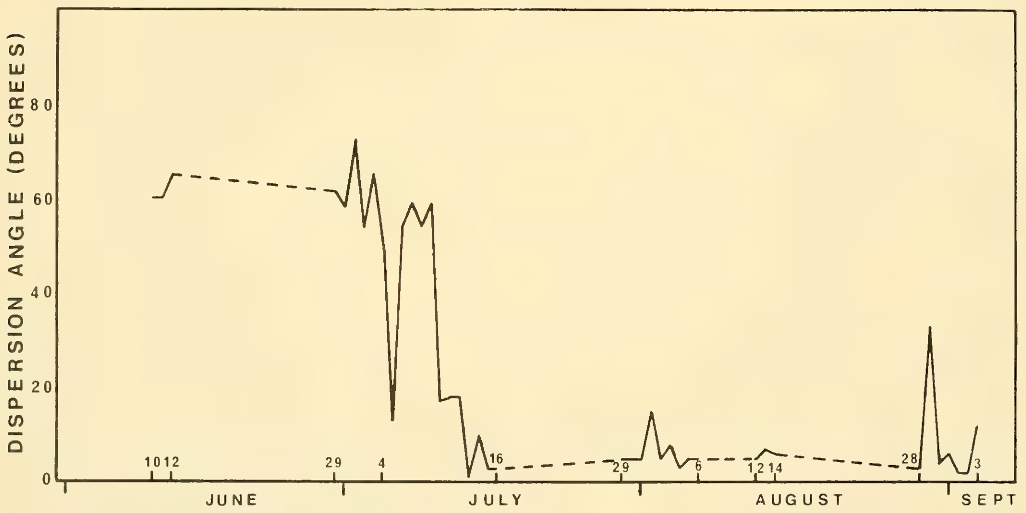

FIGURE 5. Dispersion angle for daily maximum number of seals hauled out during the period 10 June to 3 September 1970.

gardless of air temperature, however, the arc of spread decreased markedly after July 12. Nevertheless, the relationship between dispersion and air temperature remains, with the latter emerging as a probably significant factor.

The dispersion of the seals hauled out on the sand banks was correlated positively with their numbers ($r_{xy} = 0.394; P<0.02$). That is to say, as more seals hauled out, they covered a bigger arc over the study area. It also became obvious (see Figure 6) that the manner in which seals spread themselves changed markedly after 12 July. Before this date there was a high positive correlation ($^{r}{}_{xy} = 0.860$; $P<0.001$) between number of seals and angle of dispersion; after 12 July the correlation was highly negative ($r_{xy} = 0.712; P<0.01$).

Discussion

No classified data are available from the present study to indicate the structure of the seal population with respect to species, sex, or age. As many as 60 to 70 large seals have been seen in a group

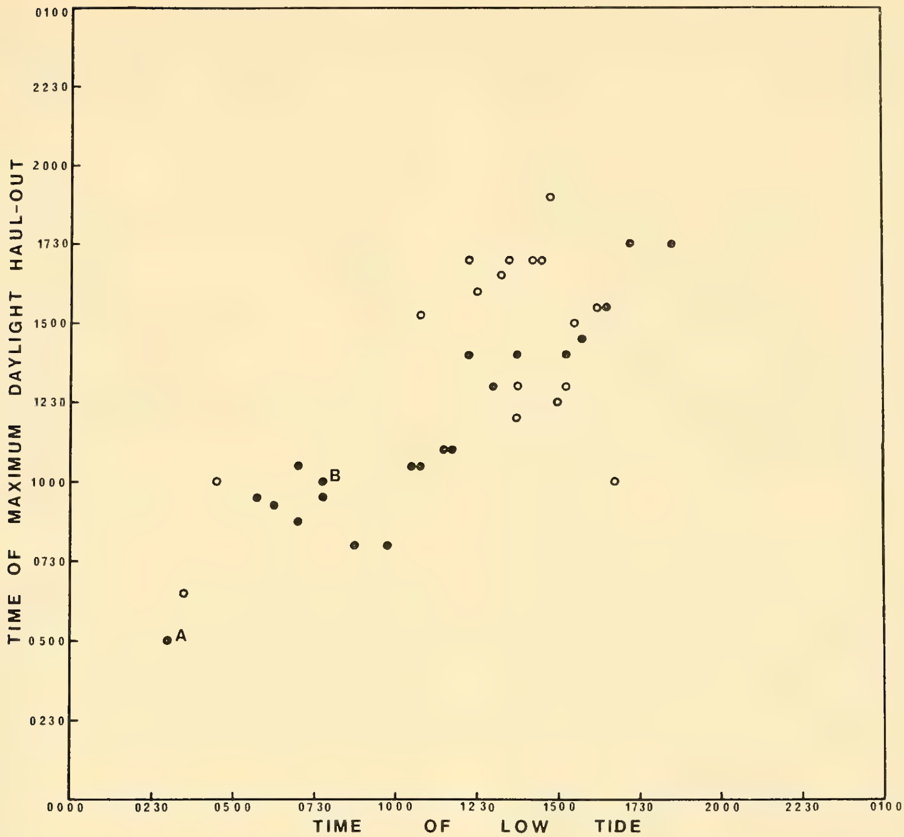

FIGURE 6. Times of maximum daily haul-out during daylight hours plotted against times of low tide at Saint-Pierre for the period 10 June to 3 September 1970. Solid circles up to and including 9 July; open circles after 9 July. The observation at A was taken after human disturbance had dispersed the seals, and that at B was the only one for the day; both should be ignored in the present discussion.

and are believed to have been adult gray seals; the status of the remainder is problematical; they were generally smaller and could have been adult or immature harbor seals or immature gray seals.

It seems most probable that harbor seal cows give birth to their pups in the Grand Barachois, which is perhaps used as a nursery area for the lactation period. As many as 100 pups may be born here early in June. Bigg (1969) gives May–June as the pupping season for this area of the species' range. Whether and where mating occurs has not been determined.

Numbers of seals, including those seen in the water from the air, were maximal on 5 June after which date there were between 350 and 400 seals until August when numbers declined rather sharply. Numbers of seals were possibly even higher before 5 June, but after that date the drop in numbers is certainly attributable to the departure of pups, parous cows, or both.

Mansfield (1967) mentioned more than 1000 gray seals at Miquelon between March and November and local fishermen reported seeing as many as 1500 seals in 1964. In 1965 several hundred gray seals were taken for their skins by a commercial firm from Carbonear, Newfoundland. Until the colony can be censused continuously, it will be impossible to say how numbers fluctuate over the year. It would be surprising, however, to find as many as have been reported previously. Numbers probably fluctuate at the various summer haul-out areas depending on several factors, not the least of which would be human harassment. Moreover, it appears that a large part of the

Miquelon seal population consists of harbor seals.

Maximum daily haul-out numbers generally coincided with low tides before 9 July, but after that date there was no relation between time of maximum haul-out and low tide. It did appear, however, that maximum haul-out and low tide more nearly coincided later in the day than earlier, indicating that some factor other than tidal conditions influence early morning behavior. For various reasons it was not possible to study the seals over the entire 24-hour period, so that haul-out behavior at night cannot be described.

The relationships between ambient temperatures and numbers of seals hauled out, as well as their dispersion are not immediately apparent. An initial high negative correlation between number of seals and temperature is followed by a high positive correlation of the same functions. One explanation could be the general discomfort experienced by pinnipeds in warm air except perhaps when peripheral warming may be important in cutaneous cell division and growth during molting. Initial scattering followed by bunching later in the season could be explained similarly.

Greater dispersion was apparent before 9 July than afterwards, with a tendency also towards scattering in low temperatures and bunching during higher temperatures. A significant change in behavior seems to occur in mid-July and it may in some way be related to temperature. Hair-shedding begins in the first week in August in *Phoca vitulina* along the coast of British Columbia (Fisher 1952) and around the British Isles (Harrison 1963). At Miquelon most harbor seals were in late stages of molt on 13 August. According to Stutz (1967), hair follicles are active as early as May in British Columbia seals; this activity precedes hair-shedding by about 3 weeks (Montagna and Harrison 1957). Feltz and Fay (1967) and Fay and Ray (1968) have suggested that certain behavioral traits observed in walrus, *Odobenus rosmarus* (L.), at the time of the molt when they form close-knit aggregations are related to the need to maintain epidermal temperatures sufficiently high to permit the necessary mitotic activity to proceed. It is therefore tempting to speculate that similar conditions hold for the harbor seals at Miquelon.

Acknowledgments

We are grateful to the Government of the Territory of Saint-Pierre and Miquelon for permission to carry out these studies at Miquelon and for providing considerable logistic support in the initial stages of the investigation. We also thank Miss C. M. Noseworthy for assistance with the statistical analyses. This work was financed by National Research Council of Canada Operating Grant A5996 to the senior author.

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Reproduction, Organochlorines, and Mercury in Northwestern Ontario Bald Eagles

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Grier, J. W. 1974. Reproduction, organochlorines, and mercury in northwestern Ontario Bald Eagles. Canadian Field-Naturalist 88: 469–475.

Abstract. A yearly census of Bald Eagles (*Haliaeetus leucocephalus*) in northwestern Ontario revealed a significant decline ($P < 0.05$) from 1966 through 1973 in the percentage of potential breeding areas that actually produced nestlings (range of 74% to a low of 36%). The average number of young per nest with young (1.5 overall) did not vary significantly during this period. Residue levels of several toxic chemicals except mercury were high in addled eggs, averaging on a dry-weight basis 94 ppm p,p′-DDE, 5.2 ppm dieldrin, 434 ppm PCB, and 2.5 ppm mercury. The shells of these eggs were significantly thinner ($P <$ 0.05) than those of eggs collected before 1947. Toxicant residue levels of eagle eggs in this region are substantially higher than in the tissues of a dead nestling eagle or in the eggs of Ospreys (*Pandion haliaetus*) in the same region. The high PCB values suggest that the eagles are acquiring the toxicant burden outside of the nesting region.

Introduction

Reports of low rates of reproduction (e.g., Broley 1958) and relatively high levels of toxic chemical contamination (Krantz et al. 1970; Wiemeyer et al. 1972) in certain Bald Eagle populations have led to widespread concern for this species. Initial impressions of declining reproduction in some regions of the United States, particularly in Florida, the northeastern states, and near the shores of the Great Lakes were recently substantiated (Sprunt et al. 1973).

The overall status of Bald Eagle populations, however, is still far from clear. Large numbers of eagles persist and are observed during migration and in wintering regions (e.g., Fawks 1961, plus yearly updates in *Iowa Bird Life*); reproduction is not uniformly poor in all regions (Sprunt et al. 1973). We still lack information from significant portions of this eagle's range. Not until the late 1960s, for example, was it even known that substantial numbers of Bald Eagles breed in central Canada (Mansell 1965; Davis 1966; Gerrard and Whitfield 1967; Grier 1967, 1969; Gerrard 1973; cf. Taverner 1934; cf. Robbins 1960). Furthermore, reproduction comprises only a part, and perhaps one of the least important parts, of the population dynamics of such a species (Young 1968).

Unfortunately, attempts to gain better population information are usually frustrated by logistical problems in working with the birds. Nesting birds are widely spaced in relatively inaccessible regions and are difficult to census in a statistically valid manner (see King et al. 1972 for an example of a proper census). Non-nesting birds may also be difficult to census and they are difficult to trap for marking purposes (Southern 1963); and once marked, the birds may lose or remove markers such as standard butt-end or lock-on bands (Grier, Postupalsky, Sindelar, and Gerrard, unpublished data). This possible band loss makes it difficult or impossible to interpret mortality, age structure, and longevity from subsequent recoveries. Before the true status of the Bald Eagle throughout its range can be assessed, additional information is required for all components of the population equation, from reproduction to death, and from additional geographical regions.

This paper presents 8 years (1966–1973) of reproduction data for Bald Eagles in northwestern Ontario. Because of the potential importance of various toxic chemicals to the reproduction of birds of prey, I have also included the limited amount of toxicant data that I could obtain from the Bald Eagles in this study area.

Study Area and Methods

The study area involves approximately 40,000 square miles of boreal forest, lakes and rivers in the western corner of Ontario, located between 49–53° North latitude and 92–95° West longitude. Detailed descriptions of the study area, including a map and travel methods, are presented elsewhere (Grier 1969, 1973; Grier et al., in press).

An eagle's reproduction may be measured in several ways. Two of the most frequently used indices for birds of prey are (1) the number of pairs *actually* producing young (and often referred to as "successful") expressed as a percentage or proportion of the *potential* number of breeding pairs present, and (2) the number of young produced per pair with young. These two components may then be combined into an overall rate for the entire reproductive element of the population.

Logistic or other problems, however, often prevent one from knowing the true potential number of breeding pairs. This number thus has to be estimated. In areas where there is a high rate of nest occupancy, the number of Bald Eagle breeding areas (defined below) yields a good estimate of the number of resident adult pairs present (Whitfield et al. 1974). Estimates of overall rates of reproduction are very similar to those determined from the number of "active" nests (Grier 1973; cf. Postupalsky, in press). Careful checks of nests late in the breeding season in northwestern Ontario showed an occupancy rate of 87% in 1971, and subsequent occupancy is believed to have remained high (Grier 1973).

A breeding area is defined as an area where a pair of Bald Eagles was breeding, attempting to breed, or had recently bred or attempted to breed (cf. Postupalsky, in press). These areas are identified by the presence of nests. Supernumerary nests (McGahan 1968) were determined as objectively as possible on the basis of proximity to other nests and the known history of use. I used the same groups of nests, when supernumerary nests were present, to represent given breeding areas for all years. Eagle nests that were taken over by other species (such as Osprey) and nests that were in obvious disrepair were not counted.

If the method is not completely accurate, and assuming that occupancy rates did not vary significantly, the method is at least consistent, and data for the different years should be comparable. The major criticism of this method (Postupalsky, in press) has been that there might be a disproportionate loss of nests in some years due to storms or other factors. This had not, however, happened in northwestern Ontario. The loss of eagle nests in the breeding areas that I censused from 1966 to 1973 was very consistent (mean loss of nests per year 12%; standard error (S.E.) = 1%) and a contingency test of the numbers is not significant ($\chi^2 = 3.36$, 6 d.f., $P >> 0.05$).

As a further point of clarification, the term "breeding area" replaces a previously used term, "territory," for semantic reasons and to facilitate comparisons with other species, particularly in tropical parts of the world (cf. Brown, in press; Postupalsky, in press). In the restricted context of Bald Eagles, "territory" as used formerly (Grier 1969; Sprunt et al. 1973; and others) is synonymous with "breeding area."

Nests were observed during the period of mid-June to mid-July each year when young were 4 to 11 weeks old. Many of the nests were climbed to band young or to check for recent use (occupancy) by adults. Six addled eggs and one dead young (estimated to be 5 to 6 weeks old) were encountered and collected during these nest visits.

The eggs were handled and measured in a manner similar to that of Osprey eggs as described by Grier et al. (in press). Various organochlorine residues in eggs collected in 1967 were measured by the Wisconsin Alumni Research Founation with techniques described by Enderson and Berger (1968). All subsequent analyses of toxic residues were performed by the Ontario Research Foundation. Their methods for organochlorine measurements are described by Vermeer and Reynolds (1970); methods for mercury determination are given by Vermeer (1971). As discussed previously (Grier et al., in press), I prefer to present and compare residues, particularly from eggs with partial drying and/or embryonic development, on a dry-weight basis. Many of the eggs were putrified when collected, but this does not appear to affect measurements of toxicants (Mulhern and Reichel 1970).

Data were analyzed with non-parametric and (or including) *Chi*-square statistical techniques (Conover 1971).

Bald Eagle Reproduction

The reproduction of Bald Eagles in this study area (Table 1) declined from 1966 to 1973. The variation from year to year is signifcant as shown by a contingency test of breeding areas with young compared to areas without young ($\chi^2 = 23.97$, 7 d.f., $P < 0.01$). A negative Spearman rank correlation between the year and the percen-

TABLE 1 — Reproduction of Bald Eagles in northwestern Ontario, 1966–1973

	Year								
	1966	1967	1968	1969	1970	1971	1972	1973	Average
Number of breeding areas	43	78	100	106	59	84	94	98	83
Number of nests with young	32	41	56	55	21	35	37	44	40
Number of young	54	57	89	89	32	51	51	76	62
Percent of areas with young	74	53	56	52	36	42	39	45	48
Number of young per nest with young	1.7	1.4	1.6	1.6	1.5	1.4	1.4	1.7	1.5
Number of young per area	1.3	0.7	0.9	0.8	0.5	0.6	0.5	0.8	0.8

tage of breeding areas with young ($r_s = -0.76$, $n = 8$, $P < 0.05$) confirms a significant direction in the variation. These results imply that some factor, or factors, is causing non-random effects.

The number of young in nests with young showed the least variability from year to year. Of a total 321 nests observed with young during the 8-year period, 159 (50%) contained one young, 139 (43%) contained two, and 23 (7%) contained three. A *Chi*-square test of year-to-year variation was 10.64, 14 d.f., $P > 0.05$, and thus not significant. This agrees with previous conclusions of others (e.g., Sprunt et al. 1973).

I do not believe that any of the decline in reproduction occurred as an artifact of the census techniques, such as from possible disturbance caused by the research. I concluded earlier through a controlled experiment that these census techniques did not affect subsequent productivity (Grier 1969). As a further check in 1973, I conducted an independent census, similar to that described by King et al. (1972), in parts of my study area that I had not previously censused for eagles. Although the techniques and main results of that independent census are being prepared for separate publication, the productivity data are included in this paper for comparison: among 92 previously censused breeding areas, 41 (45%) had young; for 35 not previously censused, 14 (40%) had young. The difference is not significant ($P > 0.05$). There appear to be no biases from previous censuses.

Toxicant Residues in Addled Eggs and Dead Chick

Residues of several organochlorine toxicants and mercury were found in addled eggs and a dead eagle chick (Table 2). The dry-weight levels of residues, where measured, were much higher in all cases in the eggs than in the tissues of the chick, even in comparisons where the percentages of fat and water are similar in the fresh tissues (e.g., Table 2, second egg in 1971 versus the chick liver). The residue levels in the eagle eggs were also much higher than levels found in Osprey eggs from the same geographical region during the same time period (Grier et al., in press, and discussed below).

Significance of Results

The productivity figures shown here can be compared with contemporary data from other regions of North America, in spite of the fact that different census and estimation procedures make the results only approximately comparable. A decline in reproduction appears to have occurred here as in many other regions; but the magnitude of the decrease has not been as great as for some localities (cf. Sprunt el al. 1973). The Bald Eagles in northwestern Ontario appear to have been reproducing at a rate comparable to that of the Bald Eagles in the interior of Wisconsin, slightly poorer than that of birds in Alaska, but much better than that of those in Florida, Michigan, Maine, and near the immediate vicinity of the Great Lakes.

Before one can assess the importance of this lowered reproduction to the population status of Bald Eagles, however, much additional information is required, namely the age structure of the population, mortality rates, and total population size. At present we have few even rough estimates of these other population characteristics. Yet such characteristics may be much more significant than reproduction for future population

TABLE 2 — Organochlorine and mercury residues in individual Bald Eagle eggs and a chick from northwestern Ontario, 1967–1972

Year	Eggshell measurements: Thickness (mm)	Weight (g)	Thickness index[a]	Percent fat	Percent water	Residues, in ppm dry weight[b]: DDT	DDE	DDD	Dield.	PCB[c]	Hg
Addled eggs collected during the nesting period											
1967[d]	NM[e]	13.45	2.86	3.99	77.9	MI[f]	44	MI	3.03	NM	NM
1967	NM	12.59	3.07	8.56	70.3	MI	95	MI	1.21	NM	NM
1968[d]	NM	12.21	2.71	15.3	71.0	2.62	121	5.17	5.83	NM	NM
1971	0.55[g]	10.02	2.26	2.4	82.9	0.35	125	13.20	7.37	977	3.51
1971	0.48	10.48	2.44	2.7	73.8	0.23	95	9.66	5.27	148	2.79
1972[h]	0.56	NM	—	21.8	13.6	ND[i]	87	1.86	8.21	176	1.18
Average	0.53	11.75	2.67			6.32	94	12.00	5.15	434	2.49
Dead young estimated age, 5–6 weeks											
Brain				3.7	90.0	ND	5.30	0.20	0.40	1.80	NM
Liver				2.0	75.5	0.05	8.72	0.41	0.45	5.97	NM
Breast muscle				1.6	78.0	ND	1.59	0.04	0.09	1.14	NM

[a]After Ratcliffe (1967) thickness index.
[b]Other residues (HE, HCB) less than 3.4 ppm dry weight.
[c]PCB reference standard = Acroclor 1260; calculations averaged from peaks #8 and #10.
[d]1967 analyses by Wisconsin Alumni Research Foundation; 1968–1972 analyses by Ontario Research Foundation.
[e]NM = not measured.
[f]MI = measurements considered inaccurate; interference of PCB not recognized at time measurements were made.
[g]Measurement included dried embryonic membranes; shell very fragile and pliable when collected.
[h]Egg contents dried when collected.
[i]ND = none detected; < 0.001 ppm dry weight.

trends in long-lived slow-breeding animals (e.g., see Mertz 1971). Young (1968) has demonstrated with simple examples that a decrease in reproduction may be far less important to an eagle population than an increase of comparable proportions in adult mortality.

The two factors that previously have been implicated in reduced reproduction in a region where significant habitat destruction has not occurred are these: (1) unusually severe winter and spring weather prior to, or during, the nesting season, and (2) interference with one or more aspects of reproductive biology by toxic environmental contaminants. These two factors, if indeed important, may be operating either alone, with each other, or in conjunction with other unidentified factors.

The apparent effects of yearly fluctuations in winter weather on subsequent eagle productivity have been noted by Postupalsky (1967, *cited in* Sprunt et al. 1973). Although the data do not yet permit a statistical assessment of the weather factor, it is worth noting that the late winter and early spring weather conditions in the central part of North America in 1973 were among the mildest on record. The 1973 productivity of Bald Eagles (Table 1) was higher than during the previous three years but it was still much lower than during 1966–1969. Weather does not appear to be completely responsible for the observed decline in reproduction.

The effects of environmental contaminants are also difficult to pinpoint statistically and conclusively. Sample sizes are small, samples were obtained on a non-random basis (i.e., only addled eggs were collected), a number of toxicant residues are present simultaneously, and only a few values from a diversity of biological tissues are available for comparison. Nonetheless, and as discussed below, two facts are clear: most of the residue levels are very high, and the shells of eggs from these birds are thin.

Compared with toxic chemical residues in various biological tissues reported elsewhere, and after adjusting for a wet-, lipid-, or dry-weight basis for reporting, most of the organochlorine levels found in these eagle eggs are high (Table 2). One egg contained 977 ppm PCB, a value that

is among the highest recorded for North American wildlife. Put in simpler terms, nearly *0.1%* of the entire dry weight of that egg was composed of PCB, a substance foreign to birds' eggs. General reviews of PCB information are given by Dustman et al. (1971), Fishbein (1972), and Peakall (1972).

These organochlorine levels in the eggs are roughly comparable to high levels recorded for Bald Eagle eggs from Maine, Michigan, and Florida and higher than in Bald Eagle eggs from elsewhere (Krantz et al. 1970; Wiemeyer et al. 1972). Residue levels from Bald Eagle carcasses vary considerably (see Reichel et al. 1969; Mulhern et al. 1970), and it is difficult to make meaningful comparisons between carcass data and egg data. The egg-residue levels of organochlorines are also comparable to levels observed in eggs and body tissues of other species with high levels, such as Peregrine Falcons (*Falco peregrinus*), as reported by several persons (e.g., Cade et al. 1968; Enderson and Berger 1968; Lincer et al. 1970). The levels are much higher than reported for eggs of Golden Eagles (*Aquila chrysaetos*) in North America (Reynolds 1969; Kochert 1972). Dieldrin levels, however, are approximately of the same order of magnitude as found in Golden Eagles in Scotland at a time when those birds were experiencing reproductive failure (Lockie et al. 1969).

Mercury levels in the Bald Eagle eggs are one to two orders of magnitude less than levels of mercury reported for ovaries of White-tailed Sea Eagles (*Haliaeetus albicilla*) in Finland (Henriksson et al. 1966). The mercury levels of the Ontario eagle eggs presented here are also considerably lower than lethal tissue levels observed in Red-tailed Hawks (*Buteo jamaicensis*) in experiments by Fimreite and Karstad (1971). Pheasant (*Phasianus colchicus*) eggs show reduced hatchability with over 1.3 ppm mercury wet weight (about 6.5 ppm dry weight) as observed by Borg et al. (1969). Levels of mercury in fish and in other species of birds in northwestern Ontario are presented by Vermeer et al. (1973) and Fimreite and Reynolds (1973).

Average eggshell thickness of the addled Bald Eagle eggs (Table 2) is 13% lower than pre-1947 eggs from the upper midwest United States and central Canada (mean = 0.611 mm, S.E. = 0.007, number (N) = 46 for actual thickness; mean = 3.15, S.E. = 0.03, N = 67 for index, J. J. Hickey and D. W. Anderson, personal communication).

The significance of the shell thickness of the six addled eggs that I obtained can be tested with a binomial test as follows. By using the pre-1947 data (above), 95% confidence limits for the mean (i.e., ± 2 S.E.) are 0.597 to 0.625 mm for actual thickness and 3.09 to 3.21 for the index. If one tests the null hypothesis that the recently collected addled eggs are from the same population as pre-1947 eggs, then the probability of getting a shell thickness below the pre-1947 mean (using the confidence interval) is 0.5. The probability of getting six eggs all below the mean (as in Table 2) is 0.5^6 or 0.016, the one-tailed significance level. For a two-tailed test, $P = 0.031$ and whichever way one looks at it, the observed shell thinning is significant; the null hypothesis should be rejected.

Earlier in the discussion I indicated that these data were obtained in a non-random, hence possibly biased manner. Any such bias should be in a *conservative* direction for addled eggs, however, because only the thicker-shelled and presumably stronger eggs would be expected to survive for long after the normal incubation period; the bias would serve to strengthen the conclusion for addled eggs. The bias does prevent one from evaluating the extent of shell thinning in the entire present-day population because non-addled eggs are not represented in the sample. But it is clear that thinning is significant in *at least some* of the eggs. And whether the thinning is the cause of eggs becoming addled or simply a sympton of some other cause, the loss of those eggs obviously contriuted to the observed decline in reproduction. In the absence of other recognized factors which contribute to reduced reproduction, the contribution of eggs that fail to hatch may be important.

DDE has been shown to cause eggshell thinning both circumstantially (Hickey and Anderson 1968; Cade et al. 1971) and experimentally (Porter and Wiemeyer 1969; Wiemeyer and Porter 1970; Bitman et al. 1969; Longcore and Samson 1973). PCB may contribute to embryonic mortality (Peakall 1972 et al. cf. Hays and Risebrough 1972). Mercury, at least at the levels observed in this paper and in several species of inland aquatic

birds, has not been implicated as a cause of eggshell thinning (Vermeer et al. 1973).

The organochlorine levels in the eagle chick found dead were much lower than in the eagle eggs, and were roughly comparable to levels found in an Osprey chick found dead in the same region (Grier et al., in press). The egg residues are also much lower in Osprey eggs in northwestern Ontario (Grier et al., in press) than in the eagle eggs reported in this paper. Because of these differences, I postulate that the eagles are acquiring most of the toxicant burden from outside of the nesting region. The eagles move relatively short distances between wintering and nesting areas and may begin egg-laying before the ice goes out, and hence probably rely heavily on stored body reserves for producing eggs. Ospreys, however, migrate much farther and probably arrive at their nests with reduced reserves of stored body materials. The Ospreys nest later, and water is open when they begin laying eggs. These eggs are probably produced from less contaminated local food supplies. The young of both species are then fed on relatively uncontaminated local food and remain relatively free of residues until they leave the region.

In conclusion, although no direct evidence exists to link high toxicant contamination to reduced reproduction in these eagles, and although no individual toxicant or specific mode of loss of eggs or young can be identified, the circumstantial evidence is very convincing. At least one, and possibly several, organochlorine toxicants appear to be responsible for lowering the reproductive rate of Bald Eagles in this region of Canada.

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Notes

A Physical and Biological Survey of La Grande River Estuary, James Bay, Quebec

Abstract. The estuary of La Grande River is a typical salt-wedge type. Temperature and salinity conditions during late summer low-water regimes range from temperate brackish shallows to subarctic marine deeps. The fauna consists of a mixture of boreal and subarctic marine species as well as some freshwater representatives.

Introduction

The estuary of La Grande River is situated on the east side of James Bay (53°50′ N, 79°00′ W). The estuary proper,[1] during summer low-water conditions, is about 10 miles long by 1 to 3 miles wide. It extends from the seaward end of Governor Island to just past the outer shoals at the river mouth (Figure 1, Stations 2 to 4).

Because of the proposed hydroelectric development of La Grande River (Glooschenko 1972), the estuary and the river have lately been the site of numerous scientific investigations by the federal and provincial governments, the James Bay Development Corporation, and the Indians of Quebec Association. This work is concerned mainly with describing the physical oceanography and the stocks of anadromous fishes situations of the river mouth. Little has been done to describe the intertidal, benthic, and epibenthic invertebrates, or the smaller fish species present in the estuary, many of which constitute the food supply of

[1]As defined by Pritchard (1967), this is the region from the seaward extent of brackish water to the up-river point where the ratio of chlorinity to total dissolved solids drops below 18:1 (ie., 0.1 parts per 1000 salinity).

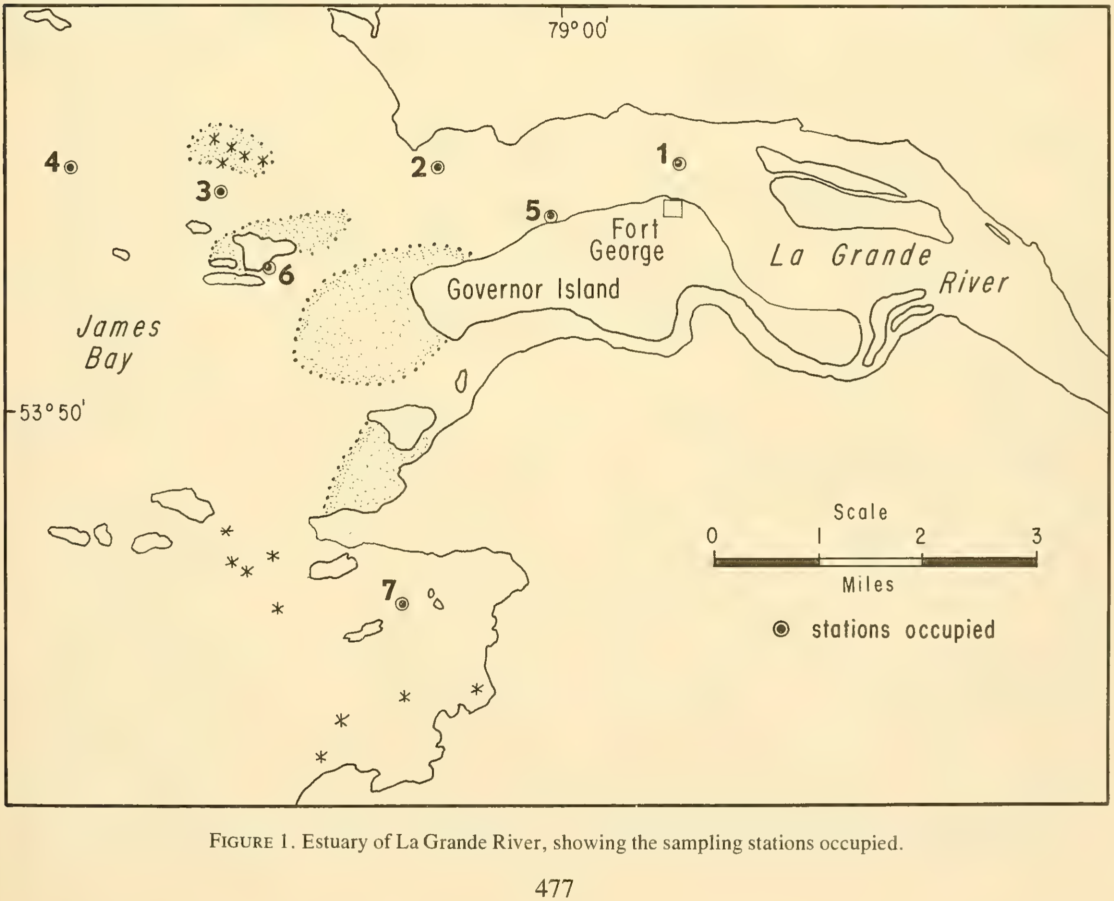

FIGURE 1. Estuary of La Grande River, showing the sampling stations occupied.

the important anadromous fishes. These invertebrate populations may be expected to undergo some changes in abundance and distribution due to changing hydrological conditions caused by the hydroelectric developments. This study was initiated to help fill this gap. The survey, however, must be regarded as preliminary since it was done over only a three-day period from August 21 to 23, 1973.

Methods

Faunal collecting was by Ekman dredge (15 × 15 × 15 cm), beach seine (20 m), gill nets, and a small (2.5 × 5.5 m) otter trawl. Temperature determinations were made with an electronic bathythermometer, and salinity readings *in situ* with a conductivity meter. Salinity readings were checked by silver chloride – potassium chromate titration on samples collected by Kemmerer bottle. Visibility measurements were taken with a 20-cm Secchi disk. Physicochemical and faunal collecting stations were located according to Figure 1. Fishes were identified by the author, while other taxa were determined by specialists at the National Museum of Natural Sciences, Ottawa.

Results

La Grande River estuary is a typical salt-wedge type, as described by Bowden (1967), with a rapid longitudinal and vertical transition from fresh- to salt-water. Figure 2 represents the longitudinal cross-section of the temperature-salinity relationship of the estuary during the survey period with a low river discharge of 43,000 cubic feet per second (Service Hydrométrie, Ministère des Richesses Naturelles, Québec). The salt-wedge estuarine situation of this river is caused by the relatively high discharge of the river into a small estuarine area on a coast with a low mean tidal amplitude (1–2 m).

Deep water of this estuary contains subarctic salt water typical of James Bay surface water (6°C, 20–26‰ (Barber 1968; Pullen 1972). Bottom

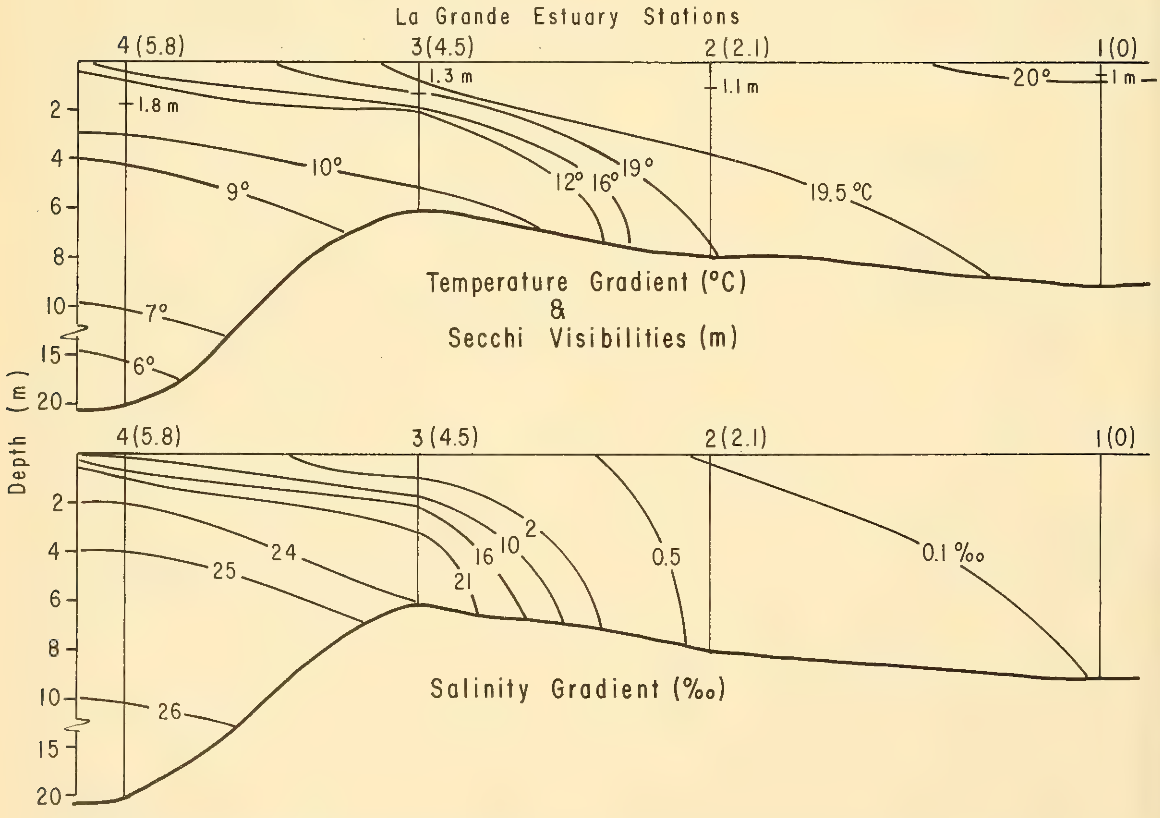

FIGURE 2. Longitudinal distribution of the physicochemical characteristics of La Grande River estuary on August 22, 1973; and, in brackets, the mileage from Fort George.

salinities (26‰) found during my survey were higher than usual summer salinities for the estuary (ie., 21‰) (Pullen 1972) but compare favorably with the deepwater salinities found by Barber et al. (1973) during winter low flows. Surface salinities and temperatures of near-shore, open James Bay water (Station 7) were higher (26‰, 11°C) than the average summer conditions (21–24‰, 6°C) found by Barber (1968) and

TABLE 1 —Physicochemical characteristics and the fauna found at various stations in La Grande River estuary. Stations situated as in Figure 1. Dash indicates species not found at locality, x indicates was found

	Stations						
	1	2	3	4	5	6	7
Bottom	clay	sand	sand	mud	mud	rock	mud
Current	fast	weak	weak	none	weak	none	none
Depth (m)	10	8	6	20	1–2	0–2	3
Temperature (°C)	20	19	10	6	20	16	11
Salinity (‰)	0	0.4	24	26	0	0.6	26
Visibility (m)	1.0	1.1	1.3	1.8	1.0	1.2	2.2
Fauna							
Polychaetes							
*Cistenides hyperborea**	—	—	x	x	—	—	—
*C. granulata**	—	—	—	x	—	—	—
Antinoella sarsi	—	—	—	x	—	—	x
Scolelepis sp.	—	—	—	x	—	—	—
Aglaophamus malmgreni	—	—	—	—	—	—	x
Crustaceans							
*Mysis oculata**	—	—	x	x	—	—	x
*Atylus carinatus**	—	—	—	x	—	—	—
Pontoporeia femorata	—	—	—	x	—	—	x
Aceropsis latipes	—	—	—	—	—	—	x
Monoculodes edwardsi	—	—	—	—	—	—	x
Gammarus setosus	—	—	—	—	—	x	x
G. oceanicus	—	—	—	—	—	x	—
Molluscs							
Macoma baltica	—	—	—	—	—	—	x
Mytilus edulis	—	—	—	—	—	—	x
Buccinium tenue	—	—	—	x	—	—	—
Admete couthouyi	—	—	—	x	—	—	—
Echinoderms							
*Urasterias linki**	—	—	—	x	—	—	—
Fishes							
Catostomus catostomus	x	—	x	—	x	—	—
C. commersoni	x	—	—	—	—	—	—
Cottus cognatus	x	—	x	—	x	x	—
Rhinichthys cataractae	—	—	—	—	x	—	—
Semotilus corporalis	—	—	—	—	x	—	—
Coregonus artedii	x	—	x	—	—	x	x
C. clupeaformis	x	—	x	—	—	x	x
Prosopium cylindraceum	—	—	—	—	x	—	—
Myoxocephalus quadricornis	—	—	x	x	—	x	x
*Triglops murrayi**	—	—	—	x	—	—	—
*Lumpenus fabricii**	—	—	—	x	—	—	—
Gasterosteus aculeatus	—	—	—	—	x	x	x
Total species	5	0	7	13	7	7	13

*Indicates taken only by otter trawl.

Pullen (1972). The generally higher temperatures and salinities found throughout this survey were probably due to the exceptionally warm dry summer experienced in eastern James Bay during 1973. Flows of La Grande were a little more than one-half normal for this time of year, that is 43,000 instead of 60,000 cubic feet per second (Taylor et al. 1972), and this may have allowed the influx of more saline water into the estuary.

The aquatic fauna of La Grande estuary is a mixture of boreal and subarctic marine species with a small freshwater representation (Table 1). This agrees with Grainger's (1968) findings for southeastern Hudson Bay. The benthic and epibenthic deepwater marine fauna has a subarctic character and is dominated by *Mysis oculata*, *Pontoporcia femorata*, *Atylus carinatus*, and *Myoxocephalus quadricornis*. The shallow-water inshore fauna contains some boreal elements such as *Gammarus oceanicus*, *Monoculodes edwardsi*, *Gasterosteus aculeatus*, and various coregonids. In general, the fauna changes from a rare and depauperate state in the freshwater river channel to a moderately abundant and diverse fauna in both the shallow and deeper marine situations (Table 1). The intertidal fauna (Stations 5 and 6) is very depauperate, possibly owing to ice scour. There is little or no intertidal algae, but sparse growths of *Fucus* sp. occur subtidally.

Discussion

Since most of the invertebrate species found were brackish-water forms, their populations can be expected to change distribution and abundance patterns with the proposed hydroelectric developments, according to the salinity and temperature changes caused by the different discharge regimes. In the long run, however, there will be a general displacement of marine populations seaward as the effects of the increased discharge (up to 100,000 cubic feet per second (Taylor et al. 1972)) are felt by 1982. The effects on the fish fauna may be more detrimental, especially if the developments hinder spawning migrations.

La Grande River is naturally turbid (Secchi readings 1–1.3 m) in its lower course, because of the easily eroded marine clays and glacial tills over which it flows (Taylor et al. 1972). This turbidity is expected to increase during construction stages, decrease during the filling stage, and then increase as flows reach about double the original levels (Taylor et al. 1972). Although turbidity may remain high, and this might possibly benefit the populations of certain photonegative organisms such as *Mysis oculata*, there could be a decline in organic detritus carried to the estuary because of deposition in the reservoirs. This drop in detrital load may cause population declines among detritus feeders and a general lowering of productivity in the estuary.

Acknowledgments

I thank Dr. John Spence and the Indians of Quebec Association for providing the necessary funds and for making this survey possible. Peter Gross and Richard Elliot assisted in various aspects of the trip and the collecting. Indians of the Fort George Band acted as guides. The identification of various invertebrates by Dr. E. L. Bousfield and staff members of the National Museum of Natural Sciences is appreciated.

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A Record-size Flathead Chub, *Platygobio gracilis* (Richardson), from Lake Winnipeg, Manitoba

On 21 August 1973, a large flathead chub (Figure 1) was caught in an experimental 3 1/4-inch (stretched measure) gill net in Lake Winnipeg near Gimli, Manitoba. It was taken in approximately 11 meters (6 fathoms) of water over a mud bottom. This unusual specimen was caught and first noted by Mr. S. Solmundson and is now in the Royal Ontario Museum (ROMZ 29842). At the time of capture it was 367 millimeters (14.5 inches) total length and 440 grams (15.5 ounces) in the round. Selected measurements and counts are given in Table 1.

The largest previously recorded flathead chub, 317 millimeters (12.5 inches) total length, was taken from the Peel River, Northwest Territories (McPhail and Lindsey 1970). The next largest specimen measured 290 millimeters (11.4 inches) total length and was also taken from the Peel River (Scott and Crossman 1973). Our specimen is 50 millimeters (2 inches) longer than the largest recorded flathead chub. Two large previously recorded flathead chubs from Manitoba were a 294-millimeter fork length specimen from Kelsey Lake (ROMZ 13834) and a 250-millimeter total length specimen from Lake Winnipeg (ROMZ 16325). The latter specimen compares in size with a 230-millimeter standard length flathead chub taken from the Missouri River in South Dakota (Olund and Cross 1961).

TABLE 1 — Selected measurements (mm) and counts for a record-size flathead chub, *Platygobio gracilis,* captured in Lake Winnipeg, Manitoba

Total length	367
Standard length	285
Fork length	329
Body depth	69
Head length	64
Number of anal fin rays	8
Number of dorsal fin rays	8
Number of pectoral fin rays	16
Number of pelvic fin rays	7
Lateral line scales	53
Scales above lateral line	7
Scales below lateral line	6
Age (years)	7

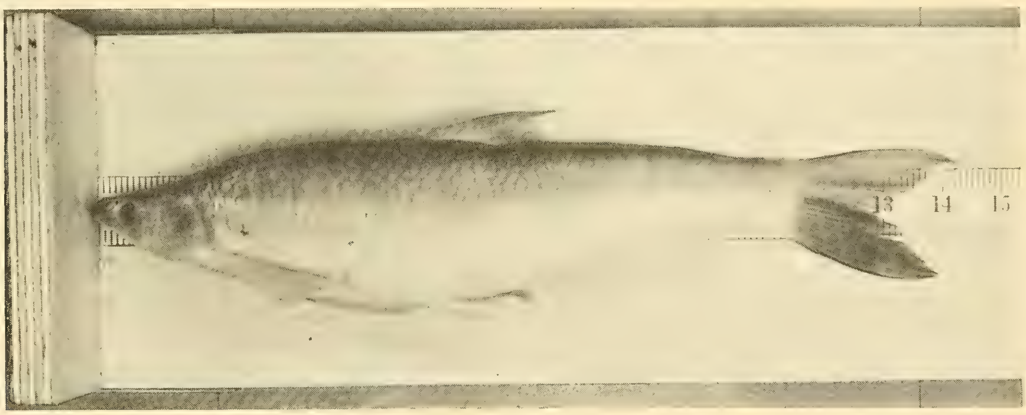

FIGURE 1. Flathead chub, *Platygobio gracilis*, 367 mm total length, 285 mm standard length 440g (round), collected 21 August 1973. The scale on the measuring board is in inches.

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Patterns of Foraging by a Pair of Eastern Kingbirds

Some of the advantages of spatial and temporal patterns of foraging by adult birds during the nestling period have been considered by Ricklefs (1971). For Eastern Kingbirds, *Tyrannus tyrannus* in particular, Morehouse and Brewer (1968) showed that the feeding rate at any given nest varied with the time of day. More recently Leck (1971) found that the duration of kingbird foraging flights was related to the size of prey taken. To investigate the use of time and space by adult kingbirds with regard to their foraging activities during the nestling period, I collected data on a single pair of birds. The study was conducted between 28 June and 5 July 1973, at Guelph, Ontario.

Concentric circles, centered on the kingbirds' nest and with radii of approximately 100 feet to 800 feet (increasing by 100-foot increments), were marked off. The temporal and spatial components of the birds' foraging activities were measured in terms of the time spent by each bird in one of the eight 100-foot intervals. Foraging was considered to be any active pursuit of prey and included shorts rests between sorties. Pursuit flights and interim rest periods were measured in seconds.

The habitat in which the kingbirds were observed foraging comprised approximately 6 hectares of initial-stage old-field succession. Goldenrod (*Solidago* sp.) was predominant, and scattered throughout the area were small stands of eastern white cedar (*Thuja occidentalis*).

Data were collected on consecutive days to cover the time period 07:00 to 21:00, and subsequently treated as if collected on 1 day for 14 continuous hours. Although this method of observation is subject to the vagaries of weather, which may affect samples, it was successfully used by Verbeek (1972) in studying time budgets of the Yellow-billed Magpie, *Pica nuttalli*. As difficulty was encountered in sexing the kingbirds in the field, the data represent the combined activity patterns of both parents.

During the 14 hours of observations, 405 minutes (or 48% of the time) was spent by the kingbirds in foraging. Figure 1 shows the temporal component of the kingbirds' daily foraging pattern. Foraging activity was low in the early morning. Between 10:00 and 11:00 there was a rapid increase in feeding rate, with both kingbirds foraging for nearly 50 minutes. This

FIGURE 1. Temporal foraging pattern by a pair of Eastern Kingbirds.

increased feeding rate may have been in response to a rise in insect activity resulting from warming temperatures during mid-morning. Two further peaks in foraging activity occurred, one in mid-afternoon and one just before sunset. Why these peaks occurred when they did is not entirely clear, but perhaps is related to the food requirements of the young, or the pattern of insect activity.

A definite spatial pattern was apparent in the kingbirds' feeding regime. Of the 405 minutes in which the kingbirds were observed foraging, 16.6% of the time was spent within 200 feet of the nest, and 10.0% of the time beyond 600 feet. Most (46.0%) foraging took place between 300 feet and 500 feet from the nest. The remaining time (27.4%) was spent about equally between 200 to 300 feet and 500 to 600 feet. This pattern may simply reflect the distribution and abundance of the flycatchers' preferred food. But perhaps the optimum distance from the nest where foraging occurs is a compromise between the following two factors: (1) foraging too close to the nest may advertize the eggs and/or young, and (2) foraging at a distance may leave the nest exposed and unprotected. But there may be some selective advantage in foraging in this manner which optimizes feeding efficiency, the nature of which was not apparent in this case owing to insufficient data.

As Ricklefs (1971) pointed out, feeding patterns in some avian species probably reflects problems of heat dissipation in the foraging adults. The pattern found in kingbirds may to some degree be explained on these grounds. Although caution must be exercised in interpreting the results of this short study, the data do suggest that there is a distinct temporal and spatial component in the kingbirds' daily foraging activities. These components perhaps combine to provide the parents with an efficient strategy which maximizes energy intake from the food available to the parents to raise their young.

I thank A. L. A. Middleton for his critical comments on the manuscript.

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Occupation d'un Nid du Merle d'Amérique par un Mainate bronzé

Abstract. A nest of the American Robin (*Turdus migratorius*), the construction of which began about 2 May 1971 at Harrington, Quebec, was taken over by a Common Grackle (*Quiscalus quiscula*) about 2 weeks later. The Common Grackle incubated four of its eggs and two of the American Robin but abandoned all the eggs during the last week of May.

En observant le nid d'un Merle d'Amérique (*Turdus migratorius*) dans le cadre de données recueillies pour le Fichier de Nidification des Oiseaux du Québec, j'ai observé qu'un Mainate bronzé (*Quiscalus quiscula*) a par la suite pris possession de ce nid. Ces observations ont été faites au Centre écologique de la Compagnie Internationale de Papier du Canada (CIP) dans la municipalité de Harrington, comté d'Argenteuil. Le Centre écologique est situé à 129 km (80 mi) au nord-ouest de Montréal et à une altitude de 182 m (600 pi).

Le nid du Merle d'Amérique était situé entre la cime de deux jeunes cèdres (*Thuja occidentalis*), à une hauteur d'environ 4 m (13.2 pi) du sol. Ces cèdres se trouvaient à moins de 1 mètre (3.3 pi) d'un édifice et à 6 mètres (19.8 pi) d'un passage assez achalandé reliant cet édifice à un autre. Le nid était construit de brindilles, de brins d'herbes et de boue; l'intérieur était garni d'herbes fines.

Deux plantations de pin rouge (*Pinus resinosa*) de faible étendue étaient situées à quelques 80 m (264.0 pi) du nid et chacune des plantations logeait environ cinq nids actifs de Mainates bronzés. Le Merle d'Amérique a commencé la construction de son nid vers le 2 mai 1971, mais 2 semaines plus tard ce même nid était occupé par un Mainate bronzé qui couvait quatre de ses oeufs et deux du Merle d'Amérique. Le mainate a abandonné le nid durant la dernière semaine de mai.

D'autres cas d'utilisation d'un même nid par plus

d'une espèce ont été observés ailleurs. À Chicago, un Cardinal (*Cardinalis cardinalis*) aidait un couple de Merles d'Amérique à nourrir leurs jeunes au nid (Logan 1951). Dans un autre cas, un Merle d'Amérique partageait la responsabilité de l'incubation avec une Tourterelle triste (*Zenaida macroura*); ces deux espèces avaient partagé un nid l'année précédente (Raney, *dans* Bent 1962). A Catonsville, Maryland, un couple de Cardinaux et un couple de Pinsons chanteurs (*Melospiza melodia*) utilisaient simultanément le même nid (Brackbill 1952).

Le mainate a peut-être abandonné le nid à cause de mes visites au nid et à cause de la circulation de plusieurs personnes utilisant le passage à proximité du nid. La période d'incubation étant approximativement le même pour les deux espèces, il est possible que tous les oeufs auraient éclos simultanément: la période d'incubation pour le Merle d'Amérique est habituellement de 12 à 13 jours (Godfrey 1966) et celle du Mainate bronzé habituellement de 11 à 12 jours (Petersen et Young, *dans* Godfrey 1966).

Je tiens à remercier M. L. Walker de Montréal, Québec de m'avoir assisté dans la consignation des données, ainsi que M. Henri Ouellet du Musée National des Sciences Naturelles du Canada, pour ses suggestions et son analyse du manuscrit.

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Received 2 April, 1974
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Ring-billed and California Gull Nesting Colony in South Central British Columbia

On a tip from Vaughan Wesseloh of Calgary that gulls had been reported nesting north of Okanagan Landing, British Columbia, I investigated the area on May 29, 1972. On Whiskey Island (50°06′ N, 119°28′ W) I found and photographed a small colony of nesting Ring-billed Gulls (*Larus delawarensis*) and California Gulls (*Larus californicus*). The species were identified on the basis of leg and bill color. This is the first recorded instance of these species nesting in British Columbia (I. McT. Cowan, personal communication). One additional pair, that of a Glaucous-winged Gull (*Larus glaucescens*) mated to a Herring Gull (*Larus argentatus*), was also present and is the subject of a note in this issue (Merilees 1974).

Whiskey Island is a small rocky islet, partially vegetated, lying about 400 yards off the east shore of Okanagan Lake. Apparently, during times of very low water, this islet is connected to the shore by a gravel bar. Owing to this feature, a navigation marker has been placed at the island's southernmost point.

In all, three visits were made to the colony. From the data collected the breeding chronology for this colony appeared very close to that presented by Vermeer (1970) for Manitoba during 1964.

On May 29, 98 Ring-billed Gull nests containing 286 eggs were counted, 8 with one egg, 30 with two, 40 with three, 8 with four, 6 with five, and 6 with six. Empty nests were presented but not tallied. At this time clutch initiation would be about 97% complete (Vermeer 1970). But the high proportion of four-, five-, and six-egg clutches is not in agreement with Vermeer's findings and may represent human disturbance, as the island is in an area of high recreational use. On this date the lone California Gull nest contained two eggs. These measured 64 × 46 and 66 × 47 mm approximately, respectively. No Ring-billed eggs were measured. Bent (1921) gives the egg size for the California Gull as 67.5 × 45.5 (average, 50 eggs) and for the Ring-billed Gull as 59.3 × 42.3 (average, 40 eggs). On June 11, the colony was visited again and rising lake waters had flooded out many of the nests including that of the California Gull pair. Owing to very rough and stormy weather, no census was made of the remaining nests.

On July 5, a third visit was made, at which time a careful count located 62 young Ring-billed Gull chicks of which 11 were banded. At this time none of the young were flying, though at a colony near Coulee City

in Washington State, young were noted flying on June 25. Vermeer (1970) records the average Ringed-billed Gull fledged on July 11, 1964 for Manitoba.

When the colony at Whiskey Island became established is uncertain. The late Allan Brooks spent a considerable amount of time in this area up to 1945, but according to Allan Brooks Jr. (personal communication) his field notes make no mention of nesting gulls. Local residents give contradictory evidence for the colony as between 5 and 30 years.

The island is also used by nesting Canada Geese (*Branta canadensis*) and in years past the local Rod and Gun Club erected goose tubs hopefully to increase nesting, but these were in disrepair and appeared unused during 1972.

Whiskey Island is privately owned and the present owner is interested in seeing the island's wildlife protected. Efforts are being made to afford the island additional protection.

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A Glaucous-winged Gull Mated to a Herring Gull on Okanagan Lake, British Columbia

Between late May and early July 1972, three visits were made to Whiskey Island (50°06′ N, 119°28′ W), a small islet in northern Okanagan Lake. In addition to 98 nests of Ring-billed Gulls (*Larus delawarensis*) and one nest of California Gull (*Larus californicus*) with eggs on May 29, there was one additional pair of birds comprising a Glaucous-winged Gull (*Larus glaucescens*) mated to a Herring Gull (*Larus argentatus*). Their nest, containing three eggs, was located on top of the island away from the other species. No other individuals of these two species were observed during the three visits.

The Glaucous-winged and Herring Gulls were separated from the Ring-billed and California Gulls on the basis of their larger size and pink rather than yellowish legs. The Glaucous-winged and Herring Gull were separated and identified on the basis of wing tip coloration, gray with white for the Glaucous-winged, and black with white for the Herring. Iris color confirms this determination. Photographs are available, both color and black-and-white, to substantiate these observations.

On May 29 the eggs were measured (73 × 52, 74 × 51, and 80 × 53 mm, approximately). By comparison, Bent (1921) gives the egg size for the Glaucous-winged Gull as 72.8 × 50.8 mm (average, 47 eggs), for the Herring Gull as 72.3 × 50.5 (average, 45 eggs), for the California Gull as 67.5 × 45.5 (average, 50 eggs), and for the Ringed-billed Gull as 59.3 × 42.3 (average, 40 eggs).

On June 11 one of these eggs was cracked and on July 5 the cracked egg remained while the shells of the other two were present. The manner in which these shells were lying indicated hatching rather than predation. Although a very careful search was made, no young could be located and although both adults were present, they were not excited nor disturbed by our presence.

During all three visits the Glaucous-winged individual was "spooky" and preferred to remain settled on the water a short distance offshore. The Herring Gull remained close to the nest site. Though uncertain from these observations, it is the feeling of the author that the Glaucous-winged Gull was the male and the Herring Gull the female.

In British Columbia the breeding distribution of these species is strictly allopatric. This present observation is at an isolated location outside the breeding range of each species. The nearest known nesting location for the Glaucous-winged Gull is in the vicinity of Vancouver (Drent and Guiget 1961), 200 miles approximately southwest. The Herring Gull is known to nest at Bridge Lake, approximately 120 miles northwest (Munro and Cowan 1947). Records of the

Glaucous-winged Gull far inland are unusual (Merilees 1961; Salt and Wilk 1966), and at present this is the only observation of this species for the Okanagan Valley (Steve Cannings, personal communication).

Interbreeding of the Glaucous-winged Gull and Herring Gull was found to be common and widespread in the Cook Inlet region of Alaska and is suspected to occur in other regions of that state where these species are sympatric (Williamson and Peyton 1963).

The breeding between these two species in the Okanagan Valley is an example of an unusual pairing which has taken place when members of the birds' own species were not available.

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First Records of the Brambling for British Columbia

On Februay 7, 1971, a Brambling (*Fringilla montifringilla*) was discovered by John and Jennifer Davies at their feeding station, 5 miles south of Tlell, Queen Charlotte Islands, British Columbia. The finch remained in the vicinity of their backyard associating with Dark-eyed Juncos (*Junco hyemalis oreganus*) for about 4 weeks. On February 25, a number of 35-mm color transparencies were taken (one photo shown as Figure 1), five of which have been deposited in the photoduplicate file of British Columbia vertebrate records (PDF 219) in the Provincial Museum, Victoria (see Campbell and Stirling 1971).

Nearly a year later, on February 5, 1972, another Brambling (possibly a female in winter plumage) was identified by Francis and Dorothy Richardson and Linda Carter at a feeder in Tlell. The bird was examined for 10 minutes after which it was not seen again. No documentary photographs were obtained, although the observers indicate the bird was similar to the Brambling photographed by the Davies the previous year.

The following winter, on November 7, 1971, Jack and Eileen Husted reported a Brambling at the George C. Reifel Migratory Bird Sanctuary, on Reifel Island in the Municipality of Delta, which is about 485 miles south, along the coast, of the Tlell sightings. Local birders were notified and the following day Brian Davies and Terry Finch saw it. Neil K. Dawe obtained 22 35-mm color transparencies the same day, all of

FIGURE 1. Brambling, *Fringella montifringilla*, in winter plumage, near Tlell, Queen Charlotte Islands, British Columbia, photographed 25 February 1971.

which are on file in the Provincial Museum (PDF 192). The finch, a male in winter plumage, remained at the refuge for 2 days and was last seen on November 9.

The possibility exists that these records may be of escaped cage birds, especially since such finches are known to be kept by aviculturists. Because of the location, it seems less likely that the Tlell sightings are escapees. To confirm this assumption 16 cage bird societies and independent bird breeders in the Pacific Northwest, that is from Seattle to Vancouver, were contacted. None reported missing Bramblings.

This colorful finch breeds in woodlands across northern Eurasia and migrates to the south in winter, sometimes in exceptional numbers. Muhlthalen (1952) estimated that 72 million Bramblings roosted in two small pinewoods in Switzerland during the winter of 1950–1951. These mass irruptions are very extensive and in recent years Eriksson (1970a) has noticed an influx of Bramblings in Finland during the winters 1951–1952, 1956–1957, 1962–1963, and 1964–1965. Eriksson (1970b) has also documented irruptions for redpolls in northern Europe for many of the same winters. Active bird dispersal, resulting from such irruptions, may be responsible for the casual occurrences of Bramblings in western North America. Since the early 1900s this Eurasian finch has been reported on the Pacific coast of North America on at least nine occasions, most within the past decade. Up to 1968 there were five reports, namely St. Paul Island, 1914 (Hanna 1916); Amchitka Island, 1957 (Kenyon 1961); Amchitka, 1961 (D. G. Gibson, personal communication); Hooper Bay, Alaska, 1967 (Springer 1966); and Portland, Oregon, 1968 (Banks 1970). D. G. Gibson (personal communication) also tells me that there are at least two recent records for Alaska: Adak, 1971 and Juneau, 1969–1970.

The possibility that the British Columbia sightings are wild birds appears more convincing when the recent Alaskan records are considered. These records and the irruptive nature of Bramblings which would aid geographical dispersal of the species could, therefore, account for its appearance in western North America.

I thank those people mentioned in the text for permission to incorporate their information into this note.

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White-tailed Deer and Mule Deer Observations in Southwestern District of Mackenzie, Northwest Territories

Little is known about the numbers and distribution of deer in the Northwest Territories. Hall and Kelson (1959) included the southwestern corner of the District of Mackenzie as the northen limit of mule deer (*Odocoileus hemionus*) range. Deer have been recorded near Fort Liard, the South Nahanni River, the west end of Great Slave Lake, and as far north as Fort Simpson and Wrigley on the Mackenzie River. All reports indicated that deer were rare and that the species involved was the mule deer (Kuyt 1966). Hall and Kelson (1959) gave the northern distribution of white-tailed deer (*O. virginianus*) in North America as an east-west line at about 54°N latitude. Cowan and Guiguet (1965) and Soper (1964) indicated the presence of white-tailed deer in the Peace River area of British Columbia and Alberta at about 56°N latitude, which was approximately the same as that given by Krämer (1972). Kuyt (1966) reported the first observation of white-tailed deer for the Northwest Territories from the Fort Smith region.

FIGURE 1. Mule deer distribution as outlined by Hall and Kelson (1959), white-tailed deer distribution as outlined by Krämer (1972), and location of nine recent deer observations in the southwestern District of Mackenzie.

In view of the approximate northern range limits of deer as given by those authors (Figure 1), I have recorded several reports of deer that came to my attention while I was conducting an ecological assessment of the South Nahanni and Flat Rivers region.

(1) On November 2, 1969, Mrs. Mary Kraus, who lived at the hotsprings near First Canyon on the South Nahanni River, found seven wolves lying in the snow near a trail about 1 mile east of her cabin. The wolves had fed on a deer and only the antlers and upper portion of the skull were left. The antlers were typical of a male white-tailed deer approximately 2 1/2 years old. The head was later given to H. J. Monaghan of the Territorial Game Management Division.

(2) Mrs. Kraus observed a doe and fawn being pursued by a wolf on September 6, 1970. The doe escaped by swimming from the hotsprings area across the South Nahanni River to the north bank. The fawn was killed by the wolf shortly after separation from the doe. The writer observed both sets of deer tracks on the following day but was unable to determine whether the tracks were those of mule deer or white-tailed deer. After discussion with Mrs. Kraus, I have little doubt that these animals, which she referred to as "jumping deer," were white-tailed deer. On two other occasions between the dates of the above wolf-kill observations, deer tracks were seen by Gus and Mary Kraus on the river bar just below their cabin. Gus Kraus also reported that the major concentration of deer occurred approximately 12 miles downstream from their hotspring cabin, on a ridge below Twisted Mountain, north of the South Nahanni River.

(3) In July 1966, William D. Addison, Wendy Addison, Don Turner, and John Brucker saw a white-tailed deer buck downstream from the mouth of Wrigley Creek, between Hell's Gate on the South Nahanni River and its confluence with the Flat River (61°34′ N, 125°28′ W). W. D. Addison is a biologist in Ontario, and Turner is a big-game guide in the Mackenzie Mountains.

(4) Stirling Pickering, University of Alberta, and two companions observed a doe and fawn, unidentified as to species, on the banks of the South Nahanni River about 30 miles north of Glacier Lake, during the summer of 1971.

(5) Freddie Tsetso reported shooting four of nine white-tailed deer from a herd wintering northwest of Little Doctor Lake in January of 1959 or 1960 (reported to M. Tennert, Territorial Game Management Division, 1971). Tsetso has since seen tracks of deer in the same area, but he believed deep snow and wolves have reduced deer numbers considerably. The species of deer involved may be doubtful, since many northern natives do not readily distinguish between the two species of deer.

(6) In June 1955, Gus Kraus observed a female mule deer on a gravel bar of Prairie Creek, near the present location of the Peñarroya Limited prospect

site (61°32′ N, 124°45′ W). The doe was first observed from a distance of about 30 feet. The sighting was made under windy conditions, with the wind blowing from the doe towards the observer. This was the only mule deer seen by Kraus in 40 years of travel in the Northwest Territories.

(7) Kraus mentioned one other incident of interest in tracing historical deer distribution in the Northwest Territories. Indians hunting Dall sheep on Nahanni Butte (61°04′ N, 123°23′ W) during the 1920s shot a deer, but they did not eat it because they had never seen one before.

(8) E. B. Owen, Geological Survey of Canada, reported the observation of a mule deer near the confluence of the Flat and South Nahanni Rivers in July of 1964 (Youngman 1968).

(9) During the first week of September 1973, retired R.C.M.P. Officer D. Friesen observed an adult mule deer, with shedding velvet on the antlers, at a distance of about 50 yards. That observation was made 20–25 miles northeast of Fort Providence on the Mackenzie Highway. The local grader operator had previously noted tracks in that area, but had not seen an animal. An earlier sighting of mule deer was reported from the Fort Simpson region (Bethune 1937).

The observations of white-tailed deer reported here are approximately 350 miles northwest of the northern range of the species, as given by Cowan and Guiguet (1965) or Krämer (1972). The observations are approximately 400 miles west-northwest of the first reported sighting of white-tailed deer in the Northwest Territories from the Fort Smith area (Kuyt 1966). A later report by Kuyt (1971) suggested that white-tailed deer are now of more than sporadic occurrence in the Fort Smith region. The observations of mule deer tend to support the northern range limits suggested by Hall and Kelson (1959).

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Range Extensions for the Bushy-tailed Wood Rat in the Northwest Territories

While conducting ecological research in the South Nahanni and Flat Rivers region during 1970, Scotter met a team of spelunkers led by Jean Poirel, who were studying some of the caves near the First Canyon of the South Nahanni River. The team members described a small rodent they had seen in one of the caves and asked what it might be. From their description Scotter tentatively identified it as a bushy-tailed wood rat *(Neotoma cinerea)*, although he realized later that the location was north of the range as mapped by Hall and Kelson (1959).

On September 19, 1971, Scotter had the opportunity to visit one of the caves, located at approximately 61°17′ N and 124°06′ W, at an elevation of 2,300 feet. Although he set a baited live-trap in the cave to obtain a specimen, the visit was of such short duration that none was obtained. While in the cave, however, a small animal, immobilized by the glare of Scotter's headlamp, allowed him ample time to identify it as a bushy-tailed wood rat. The cave contained additional evidence of wood rats, including their nests, feces, urine stains, and piles of sticks, primarily from ground juniper (*Juniperus communis*).

On July 5, 1972, Simmons collected a female bushy-tailed wood rat at the mouth of the same cave (catalogue Number NS180). The skin and skull went to

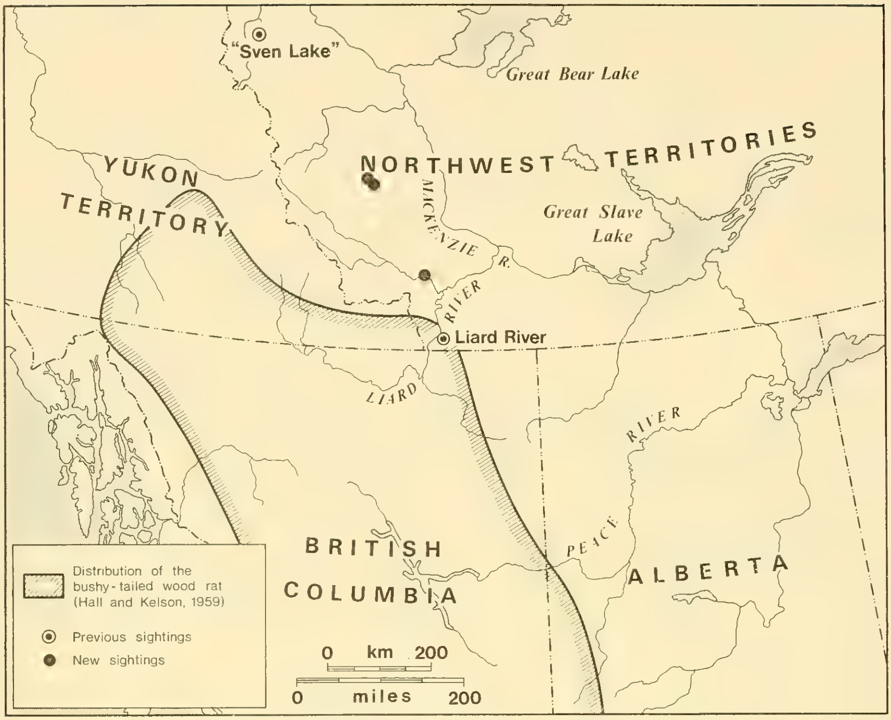

FIGURE 1. Distribution of the bushy-tailed wood rat showing range extensions.

the National Museum and the specimen was identified as *N. c. drummondii*; their catalogue number for that specimen is 42799.

In the fall of 1972, big-game guide Stewart Sinclair-Smith killed a bushy-tailed wood rat south of Little Dal Lake (62°40′ N, 126°42 1/2′ W). Around that time he also found the remains of another wood rat in the Silverberry (South Redstone) River area north of Little Dal Lake (62°40′ N, 126°45′ W). Simmons has a photograph of the wood rat Sinclair-Smith killed, which accompanied a letter from his date 10 October 1972.

The sites of these observations are approximately 75, 200, and 210 miles north-northwest of Fort Liard, the location of the first published report of a bushy-tailed wood rat from the Northwest Territories (Goldman 1910). The Little Dal Lake and Silverberry River sites are approximately 225 miles southeast of the record recently reported from "Sven Lake" by Martell and Jasper (1974). Figure 1 shows the distribution and the range extensions of the bushy-tailed wood rat.

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The Second Record of Brook Stickleback, *Culaea inconstans* (Kirtland), in Nova Scotia with Comments on Immigration

Abstract. Three brook sticklebacks, *Culaea inconstans* (Kirtland), were collected September 5, 1973 in River Phillip, Cumberland County, Nova Scotia, at the junction of this river with provincial Highway 102. This is the second record of this species in Nova Scotia. The potential of brook stickleback for immigration to River Phillip from streams of southeastern New Brunswick via Northumberland Strait, Gulf of St. Lawrence, is discussed.

The first report of the brook stickleback, *Culaea inconstans* (Kirtland), for Nova Scotia was issued by Gilhen (1970), based on one specimen (Nova Scotia Museum Catalogue 970-2-134-1(1)). The precise site of collection was not noted except that it was in River Phillip or adjacent tributary at the junction of Highway 102 (Trans Canada Highway) and the river, in Cumberland County adjacent to New Brunswick.

On September 5, 1973, we collected fish by seine and dip-net in River Phillip in a 200-m segment immediately above the bridge on Highway 102, actually to obtain ninespine sticklebacks (*Pungitius pungitius* (L.)) for experimental purposes. Some of the intermittent tributaries in which Gilhen had collected were dry at this time. We collected 13 sticklebacks cursorily identified as ninespine sticklebacks, and somewhat more than 200 threespine sticklebacks (*Gasterosteus aculeatus* L.). More intensive examination of the catch in the laboratory, however, enabled us to segregate three brook sticklebacks from the group previously identified as ninespine sticklebacks.

These specimens were 40.6, 41.5, and 47.9 mm total length, all had the normal complement of five dorsal spines, and all appeared to be of normal form and robust condition. The shortest of the three has been placed in the Nova Scotia Museum (Nova Scotia Museum Catalogue 974-2-4).

Gilhen (1970) has drawn attention to the prediction of Livingstone (1951) that the brook stickleback would be located in the Nova Scotian piscifauna in due course. Livingstone (1951) postulates that the freshwater piscifauna of Nova Scotia is entirely the result of invasion across the isthmus of Chignecto, situated between the Bay of Fundy and the Gulf of St. Lawrence, after the recession of the Wisconsin glaciation. He made this assumption on the basis of the distributional pattern of these fishes. All 12 species of provincial freshwater fishes, that is fishes which do not move freely to the sea, occur in the watersheds of northern Cumberland County. Species composition regresses in surprisingly uniform clines from this isthmus along the long axis of the province to the southwestern and northeastern extremities, and southward toward the Atlantic coast generally. The location of the two collections on the Chignecto isthmus about 30 km from New Brunswick, and the apparent absence of the species elsewhere in Nova Scotia, suggests that Livingstone's hypothesis has merit. Whether the brook stickleback is quite recently arrived in River Phillip or whether it has been long established there has no final answer because of the paucity of collecting effort, possibly inadvertent confusion with other sticklebacks, and the inherent incompleteness of negative information. If they are derived from a population of brook sticklebacks of antecedent residence in New Brunswick then two pathways are conceivable. One is overland by some transport mechanism such as extensive postglacial flooding, or animal activity such as carriage by birds or humans. The other route is by way of the saline coastal water of Northumberland Strait into which River Phillip discharges as do numerous streams of eastern New Brunswick. Lauzier et al. (1957) report that the surface layer of that part of the Gulf varies from 26–32‰ S(salinity) depending seasonally on the discharge of the St. Lawrence River. These levels appear to be beyond even very short-term osmoregulative capacities of brook stickleback.

The literature conflicts on the capacity of the brook stickleback to tolerate saline water. Field observations generally indicate higher tolerance than laboratory tests. Armitage and Olund (1962) observed debilitate life habits in this species above approximately 7‰ S. (dilute sea water) and mortality began about 10‰ S. Mortality was complete in a few hours for those exposed, even after gradual increase, to 21‰ S at ‰ °C. Nelson (1968) examined the tolerance of brook stickleback to synthetic sea-salt solutions and determined that their survival time ranged from 5 to 15 days at 16°C when the water was gradually adjusted from 0 to 14‰S.

Brook stickleback has been interpreted by Armitage and Olund (1962) as a primary species, and obligate freshwater form, intolerant on a continuing basis, of significant salinity. The extensive distribution of this species in water of at least one-half of the concentration of sea-water renders some part of their experimental technique of doubtful reliability. They further suggest that the sticklebacks (Gasterosteidae) originated as a marine group and that the form now known as brook stickleback became adapted only to freshwater by loss of some undefined salt-water capabilities. This hypothesis is contrary to the generally accepted concept of the evolutionary process and progress of teleost

(neopterygian) fishes. Structural and functional mechanisms which enable life in fresh or weakly saline water are complex particularly in the case of nephric tubules (Smith 1953). Successful invasion of strongly saline water in an evolutionary context requires some reduction of renal tubules or glomeruli or both as a major abatement of water loss. The widespread distribution of other species of sticklebacks in fresh or weakly saline waters and the invasion of freshwater by most marine sticklebacks as a fundamental part of the reproductive process also supports the hypothesis of phylogenetic origin in freshwater and secondary establishment in marine environments. Partial clarification of the issue awaits a thorough comparative microanatomic interpretation of osmoregulative surfaces of kidneys, gills, gut, and integument in all species of the family.

Acknowledgments

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Peregrine Falcon and White-rumped Sandpiper, New for Axel Heiberg Island, Northwest Territories

During the summer of 1973, while engaged in field work for the Canadian Wildlife Service, I kept detailed records of birds just north of Mokka Fiord (79°43′ N, 87°30′ W) on eastern Axel Heiberg Island. These findings largely agree with those of Parmelee and MacDonald (1960. The birds of west-central Ellesmere Island and adjacent areas. National Museum of Canada Bulletin 169, Biological Series (63) and Macpherson (1963.Faunal Notes – 1960 and 1961. *In* Preliminary report 1961–1962. *Edited by* F. Muller et al. Axel Heiberg Island Research Reports, McGill University, Montreal. pp. 221–236) and so a complete annotated list is not presented. Instead, I will detail my observations of two previously unrecorded species, the Peregrine Falcon (*Falco peregrinus*) and the White-rumped Sandpiper (*Calidris fuscicollis*).

The Peregrine Falcon was seen in good light through 10 × 40 binoculars on June 28 and July 11. In the first instance, it circled low overhead, prominently displaying its barred breast, conspicuous facial pattern and dark back. I was immediately impressed by the very large size of the bird, which suggested that it was a female. On the second occasion, a peregrine was seen actively hunting, flying very quickly along gulleys. This bird, however, appeared quite small and might have been a male. There was no evidence of breeding activity in either case. Although Godfrey (1966. The birds of Canada. National Museum of Canada Bulletin 203, 428 pp.) records this species as occurring only to Somerset Island, recent observations have extended its range northward. Waterston and Waterston (1972. Report on wildlife, vegetation, and environmental values in the Queen Elizabeth Islands. Typescript report in files of Canadian Wildlife Service, Ottawa) noted that, according to scientists at the International Biological Programme Camp on Devon Island, a pair of these falcons

nested near Cape Sparbo in 1971 and was present again in 1972. R. H. Russell (personal communication) observed an individual on the Sabine Peninsula, Melville Island on August 16, 1972. The present sightings are approximately 450 km north of either of these.

A single White-rumped Sandpiper was observed at very close range and in excellent visibility on July 11, 12, and 17. All field marks such as small size, white rump, and metallic squeaking call were evident. It was found each time in roughly the same location, a stretch of marshy tundra by a lake, and was closely associated with Red Knots (*Calidris canutus*). No nesting activity was evident. These sightings are at least 410 km north of Melville Island, the most northerly area of occurrence recorded by Godfrey (1966).

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Notes on Wintering Great Cormorants in Nova Scotia

The Great Cormorant (*Phalacrocorax carbo*) in eastern North America has received very little attention; most accounts (Bent 1922; Palmer 1962) draw heavily on European studies. Recently, Erskine (1972) provided some information on breeding numbers, seasonal chronology, and nesting success. Except for annual Christmas bird counts, however, studies in the non-breeding season are lacking. I am therefore presenting some observations made during the winters of 1971, 1972, and 1973 along the coast of Nova Scotia.

From February 12 to March 10, 1971, I attempted a ground census of all cormorants wintering between Yarmouth and Canso. I then undertook an aerial census of roosts during the late afternoons of March 21, 26, and 27. These results, along with those of a similar aerial count made by A. R. Lock during mid-days of February 7 and March 1, 6, and 8, 1973, are presented in Table 1. The difference in the two 1971 counts is largely due to the birds' being more visible from the air, especially when concentrated on roosts. Also, as the aerial survey took place in late March, some migrating birds may have been included. This could explain why Lock found many fewer birds along the eastern shore region. Numbers in the other sections were broadly similar in both years.

TABLE 1 — Number of *Phalacrocorax carbo* found in various coastal sections from Yarmouth to Canso, from ground and aerial surveys by Ross and Lock in 1971 and 1973

	Ross		Lock
Location	Ground, 1971	Aerial, 1971	Aerial, 1973
Yarmouth – Shelburne	91	126	198
Shelburne – Liverpool	51	131	115
Liverpool – Blandford	146	200	193
Blandford – Halifax	91	48	11
Halifax – West Jeddore	0	0	2
West Jeddore – Sheet Harbour	3	59	0
Sheet Harbour – Liscomb	6	20	2
Liscomb – Torbay	2	27	10
Torbay – Canso	0	63	8
Total	390	674	539

The density of cormorants along this coast is much lower than that between Montauk, New York and Cape Ann, Massachusetts where five separate annual Christmas count areas have reported over 300 *P. carbo* at some time. The present record is 680 individuals from Newport-Westport, Rhode Island in 1966. The variations in numbers from year to year (e.g., from 1 in 1966 to 403 in 1970 Quincy, Massachusetts) are not correlated with weather, and are likely due to differences in observers and observation conditions.

I located 17 evident roosting islands in 1971, the closest being 11 km apart. Although their characteristics varied, small, bald, rocky islands reaching 3–12 m above high tide seemed to be preferred, although large, treed and flat islands were occasionally used. More consistently, all were difficult to reach, often in highly exposed offshore locations and always distant from settlements. The heights of roosts were usually greater than those of daytime resting areas, presumably providing protection from spray and facilitating rapid take-off. Numbers on roosts varied widely, from 4 on Gannet Rock off Yarmouth to approximately 140 on Long Island in Mahone Bay. These do not correlate with roost characteristics although food supply and harassment from fishermen were possible influences.

On February 26, 1971, I observed the roosting flight to Long Island, Mahone Bay. The weather was clear, calm, and cool (0°C). Cormorants started to arrive either singly or in small groups from about 3:30 p.m. A.S.T. By 4:30 p.m. the flight reached its peak and the

incoming groups became larger. They flew low over the water, climbing steeply to land on ledges. As the flock grew, sitting birds were often dislodged by those arriving and flew in wide circles preparing for new landing attempts. By 5:00 p.m., the flight was largely complete as compared to that of the gulls which were just then beginning concerted roosting movements.

Foraging distances were determined by comparing locations of feeding birds with that of the nearest roost. Of 24 records, 8 were within 8 km of the roost and 15 were within 16 km; two birds were found 37 km distant. Pearson (1968) estimated that the Shag (*P. aristotelis*) foraged at an average of 18 km from its colony.

On March 31, 1972, I collected a sample of pellets regurgitated by *P. carbo* from the Long Island roost. These contained the remains of 309 fish in the following percentages: 21.7% atlantic cod (*Gadus morhua*), 0.3% tomcod (*Microgadus tomcod*), 3.6% pollock (*Pollachius virens),* 3.2% cunner (*Tautogolabrus adspersus*), 41.1% long-horned sculpin (*Myoxocephalus octodecemspinosus*), 14.6% short-horned sculpin (*Myoxocephalus scorpius*), 0.6% sea raven (*Hemitripterus americanus*), and 14.9% winter flounder (*Pseudopleuronectes americanus*).

I am very grateful to Dr. E. L. Mills, Dalhousie University, for his valuable advice during the preparation of this note. I also thank Dr. A. R. Lock for allowing use of his unpublished data.

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Some Den Sites of Manitoba Raccoons

Recent publications have documented a notable increase of raccoon numbers in the aspen parklands of southern Manitoba, a region considered nontypical raccoon habitat and located on the northern edge of raccoon range in North America (Sowls 1949; Sutton 1964; Bird 1961; Lynch 1971). In 1966 the writer compiled a list of den sites used by the raccoon population in the vicinity of the Delta Waterfowl Research Station, 89 kilometers northwest of Winnipeg. The locations of most raccoon dens were determined from interviews of 66 local residents. Other dens were found using a trained dog.

Suitable tree dens are few in the agricultural area south of Delta where cover consists of woodlots of aspen (*Populus tremuloides*), box elder (*Acer negundo*), and bur oak (*Quercus macrocarpa*), surrounded by cultivated fields of hay or grain. Immediately east and west of Delta along the shore of Lake Manitoba and to the south in the Assiniboine River bottoms, den trees are common and the raccoon populations more abundant. It is here that large cottonwoods (*Populus deltoides*) and willows (*Salix* sp.) provide ideal den sites for raccoons.

Residents of the agricultural region reported 18 raccoon dens, including five in abandoned farm buildings, three in hay lofts, two each in granaries, chimneys of abandoned work shops, and tree cavities, and one each in a hay stack, brush pile, ground burrow, and a tree-squirrel nest. Fourteen of the sites were located in abandoned or seldom used farm buildings. Brood dens were found in a hay loft and a ground burrow. Some winter den sites, located by the dog, on the ridge east of Delta Station included a brush pile, a tree den in a large willow, and two dens in snow drifts. The cavity of one snow den lay under the drooped leading edge of a drift for 3–4 meters. Diameter of the cavity was 15–25 centimeters. The other was formed by drifted snow around the trunk of a box elder. It lay vertically 80 centimeters deep (17 centimeters in diameter) against the leeward side of the tree. Snow drifts exceeding 3 meters high are common along the south shore of Lake Manitoba.

The use of cavities formed by drifting snow exemplify the adaptability of raccoons in securing dens. Butterfield (1954) and Dorney (1954) listed other examples of unusual raccoon den sites, but both pointed out that

raccoons extensively use ground burrows, particularly in areas where arboreal sites are rare. Stuewer (1948) suggested that tree cavities are typically preferred and used wherever available. Bird (1961) stated that the increase of raccoons in southern Manitoba is limited by the absence of hollow trees for denning sites. The heavy use of farm buildings by denning raccoons south of Delta was probably the result of a shortage of tree den sites and ground burrows.

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Status and Distribution of Fisher and Marten in New Brunswick

Abstract. The distribution and status of fisher (*Martes pennanti*) and marten (*M. americana*) in New Brunswick are traced from around 1775 to 1971. Presently fisher are common in northern and central New Brunswick and marten are common only in the northwestern one-third of the province. No evidence of reproduction from fisher transplanted to other parts of the province was found.

This paper summarizes information on the past and present distribution and status of fisher (*Martes pennanti*) and marten (*M. americana*) in New Brunswick. It is based on a survey of the literature, on the systematic recording of observations of animals and signs, and on documentation of releases made by the New Brunswick Department of Natural Resources.

These furbearers have been mentioned by early writers, but the first quantitative data refer to the years just prior to 1775 (Raymond 1910, p. 309). During that period, an average of 605 marten and 25 fisher were taken each year during efforts primarily devoted to the trapping of beaver.

Chamberlain (1884) stated that marten were common and that fisher were rare in New Brunswick. Adams (1873) thought that the marten population was beginning to decline.

A party from the American Museum of Natural History collected mammals in Victoria County in northern New Brunswick in 1893 and 1894, and reported fisher as not uncommon and marten as the most abundant furbearing mammal (Allen 1894).

Trapping restrictions regarding these two species were first introduced in 1877 (New Brunswick House of Assembly 1877) (Table 1). Royalties have been collected on fisher and marten pelts since 1921. The mean annual take of marten and fisher for 1921–1944 was 119 ± 21 (Standard Error) and 44 ± 4 (Standard Error), respectively. Squires (1964) stated that an examination of these records shows a very great decrease in the catch, and presumably in the population.

TABLE 1 — Summary of trapping restrictions for fisher and marten in New Brunswick, 1877–1969

Year	Trapping season	Zone
1877–1902	September 1–May 1	Entire province
1903–1908	Closed season	Entire province
1909–1912	November 1–March 31	Entire province
1913–1920	November 1–March 31[1]	Entire province
	Closed season[2]	Entire province
1921–1944	November 1–March 31	Entire province
1945–1962	Closed season	Entire province
1963–1966	December 15–December 31	Northern
1967	December 15–December 30	Northern
1968	December 16–December 31	Northern
1969	December 1–February 28[1]	Northern
	December 15–December 31[2]	Northern

[1]Fisher
[2]Marten

Rand (1944) stated that fisher were restricted to the northern one-third of the province and probably numbered less than 300. Squires (1946) believed that the royalty records showed a very great decrease in the catch and expressed the hope that the closed season declared in 1945 (Table 1) had not come too late to save these mammals from becoming extinct in the province.

Morris (1948) considered both marten and fisher to be rare and restricted to the more remote areas of the province. Hagmeier (1956) stated that marten were greatly reduced in numbers and were confined to remoter regions and that fisher were found only in central and northern New Brunswick. Hagmeier reported that a fisher from Ontario had been released in 1950 in the Burpee Game Refuge which contains the Acadia Forest Experiment Station. Peterson (1966, p. 256) stated that fisher had become extremely rare in New Brunswick, and further stated that the current status of the marten was uncertain (p. 252).

A short open season was declared in 1963, since trappers complained that they could not keep these species out of traps set for other furbearers. Based on royalty records between 1963 and 1968, the mean annual take of marten and fisher was 180 ± 39 (Standard Error) and 139 ± 26 (Standard Error), respectively.

Between 1965 and 1971, sightings and track observations of fisher and marten were recorded by the field personnel of the New Brunswick Department of Natural Resources. These observations were plotted for each species (Figures 1 and 2).

In recent years, fisher appear to have expanded their range southward from the northern one-third of the province into central New Brunswick. This extension apparently has not progressed as rapidly as the range extension documented for this species in Maine (Coulter 1960). Although common where it is found, the marten is still limited to the northwestern one-third of New Brunswick. The marten population has a similar distribution pattern in Maine (Coulter 1959). Coulter thought that the restricted range of the marten in Maine probably was due to the possibility that marten are not as adaptable to habitat changes as is the fisher.

Reviews (Benson 1959; Peterson 1966, p. 256; Dodds and Martell 1971) of the status of fisher reintroduced into Nova Scotia indicate that fisher are now successfully re-established in that province.

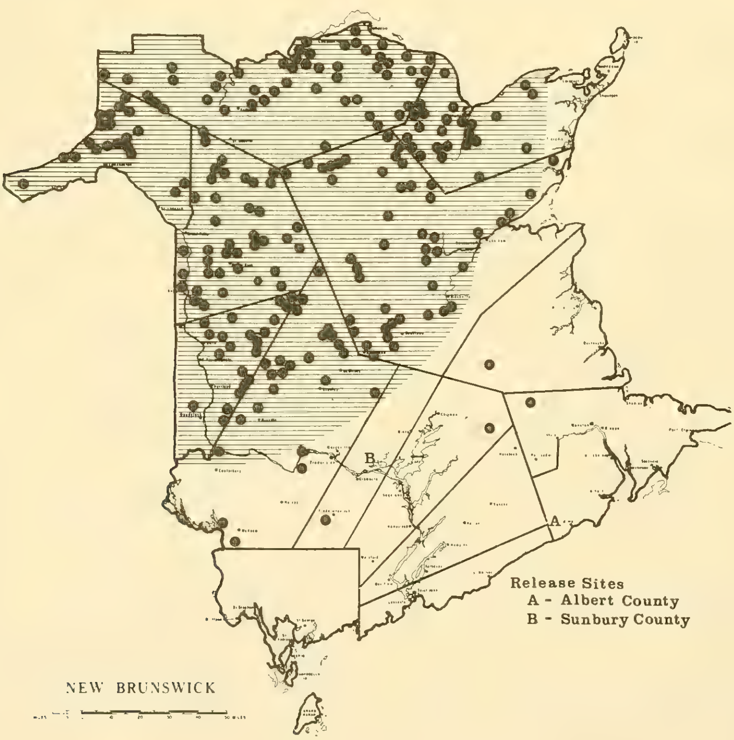

FIGURE 1. A map showing the distribution and release sites of fisher in New Brunswick. The shaded portion represents the portion of the province where fisher are common. Each dot represents one or more sightings and/or track observations.

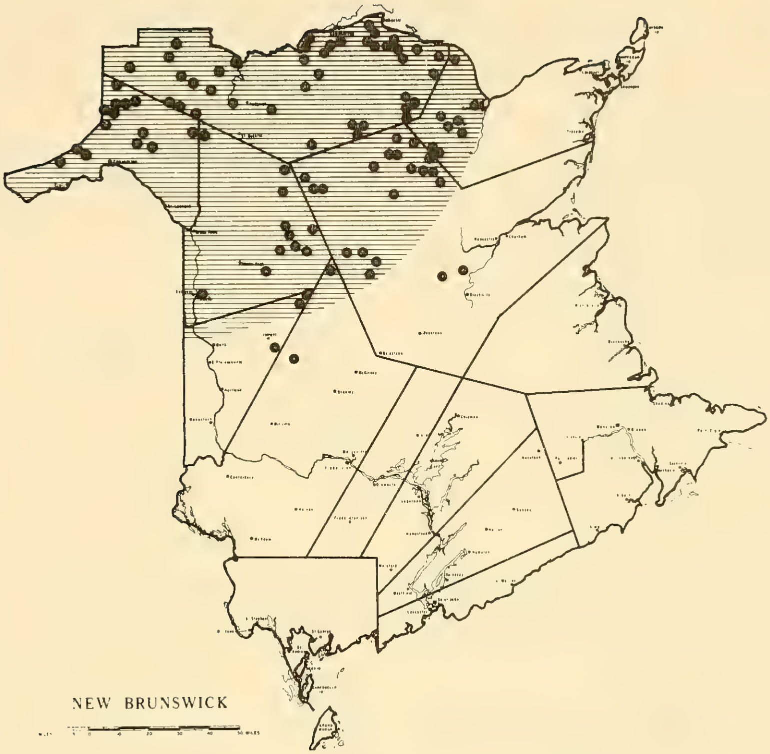

FIGURE 2. A map showing the distribution of marten in New Brunswick. The shaded portion represents the portion of the province where marten are common. Each dot represents one or more sightings and/or track observations.

The Department of Natural Resources of New Brunswick undertook a live-trapping and transplant program for fisher in 1966 to attempt to re-establish fisher in portions of its former range. It was hoped that, once established, the fisher would be an effective predator of porcupine (*Erethizon dorsatum*). Live-trapping was conducted in March and early April in 1966, 1967, and in 1968 in the Kedgewick and Tetagouche River watersheds of northern New Brunswick. In the first year, eight fisher (three males, five females) were released in the upper basin of the Pollett River in Albert County near Fundy National Park (Figure 1). Nine animals (five males, four females) were transplanted in 1967 to the Acadia Forest Experiment Station, Sunbury County. The 1968 release of eight animals (two males, six females) was again in Albert County.

Of the released fisher, one was later shot in the Sunbury County, two were trapped and one road-killed in Albert County. The maximum distance between release and recovery sites was 18 miles. From 1968 to 1971, fisher were observed eight times and tracks observed six times near where they were released in Albert County. There has been no evidence of reproduction of the transplanted animals.

Acknowledgments

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A Deletion from the Known Range of the Gray Treefrog (*Hyla versicolor*) in New Brunswick

A continuing puzzle for students of herpetology has been the distribution of the gray treefrog, *Hyla versicolor*, in New Brunswick. Gorham (1972) compiled all provincial records of it: 16 extant museum specimens from the Fredericton area, and reports of a single specimen from Gloucester County and two from Restigouche County.

New Brunswick's first herpetologist, Dr. Philip Cox (1898, 1899) noted that the Gloucester County specimen, captured by Dr. A. C. Smith of Tracadie, N.B., was the only provincial representative he had examined of *H. versicolor*. The specimen at that time was in the museum of the Miramichi Natural History Association, Chatham, N.B., but Bleakney (1958, p. 16) was unable to locate it there in 1955. The Tracadie area of Gloucester County, approximately 130 miles northeast of Fredericton, seems an unfavorable locale, from the standpoint of climate and vegetation, for *H. versicolor*, but Gorham (1972), basing his opinion on Dr. Cox's reputation as a zoologist, was inclined to accept the report.

In August 1973, the writer discovered, in the Chatham museum, a corked vial containing a dried, shrunken specimen and a label bearing the notation "H. versicolor Glou." It closely resembled *H. crucifer*. After treatment at the New Brunswick Museum, to rehydrate and relax it, Gorham found that tibia length, snout-to-vent length, position and size of vomerine teeth, shape of snout and head, the smooth brownish skin, and the plainly visible dorsal cross (which was distinctly visible even before the specimen was rehydrated), all were characteristic of *H. crucifer*. The specimen was a male, approximately 28 mm in snout–vent length, with a well developed vocal sac. His identification has been confirmed by Francis Cook of the National Museum of Natural Sciences, Ottawa.

There seems little chance that the specimen under consideration is not the one mentioned by Cox as *H. versicolor*, thus invalidating his reference to the species' occurrence in northeastern New Brunswick.

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Evidence of a Relationship between Age and Activity in the Toad *Bufo americanus*

Abstract. Sexually immature second-year toads were found to be proportionally more diurnal than adults. Activity was recorded as the number of crossings per day over a sand transect during the summer of 1971. Diurnal activity accounted for 18.6% of all juvenile activity, while only 2.6% of adult activity was diurnal. It is thought that this relatively greater diurnal activity of juveniles is ecologically adaptive.

Introduction

Several reports in the literature have described activity differences among different age groups of toads. Stille (1952) found that the daily activity of *Bufo woodhousei* varied with the age of individuals. He stated " . . . . from one or two months of age (i.e. after metamorphosis) the small toads become less diurnal and largely nocturnal like the adults." Boice (1969) noticed that juvenile *B. americanus* were less active than adults and poor in anticipating feeding times when kept in the laboratory. Ferguson (1960) found that young *B. fowleri* are predominantly diurnal during the first few weeks after metamorphosis, and Tracy and Dole (1969) reported that this was also true for *Bufo boreas*. Noble (1954) has generalized that juvenile toads are more diurnal than nocturnal in contrast to adults.

Unfortunately, the above studies, with the exception of Boice (1969), were based on casual observation rather than quantitative data. While various investigators have reported seeing large numbers of hatchlings and juveniles in daylight, this may mean little because it was not known what percentage of the total population these immature animals actually comprised. Also, immatures are less easily seen than adults after dark.

As part of a general investigation of the seasonal activity and behavior of *Bufo americanus* (FitzGerald and Bider 1974), we recorded the 24-hour activity cycle of toads and found that 6.4% of crossings on a sand transect were diurnal. We defined diurnal activity as crossings occurring between dawn and dusk. Dusk and dawn were defined as the beginning of night and day, respectively, and were determined by the use of a pyrheliometer. Details of recording procedures are given by Bider (1968).

During the general study we noticed that sexually immature toads appeared more active in the daytime than adults were, and the purpose of the present study was to investigate the possible relationship between age and activity.

Site

The study area is 2 miles north of the village of Lac Carré, Terrebonne County, Québec (46°09′ N, 74° 29′ W), an area of the mid-Laurentian series about 65 miles northwest of Montreal. Details of climate, vegetation, and topography are discussed by Bider (1968).

Methods

A sand-transect technique was used to collect activity data. This technique consisted of recording the crossings of toads that had left their prints on the fine sand. *Buflo americanus* tracks are easily distinguished from the prints of other anurans in the area. The 750 × 3 ft (246 × 1 m) transect was covered by a 2-m polyethylene canopy so that regular readings at 2-hour intervals were possible in wet weather. Readings alternated between odd and even hours every 8 days. Details of the construction of this sand transect can be found in Bider (1968).

To aid in the field classification of toads it was necessary to establish a relationship between track size and age. Adults can be distinguished from juveniles by the presence of secondary sexual characteristics (i.e., nuptial pads in the male; adult females are much larger than males and their snout–vent length usually exceeded 6.5 cm). Next, a relationship between width of a track and age was determined. Track width was the distance from the outside of one front foot to the outside of the other front foot. Measurements were taken on a number of captured toads. It was found that a track width greater than 4.9 cm was invariably that of an adult, a track width 3.0–4.9 cm was that of a juvenile (i.e., sexually immature second-year toads), and a width less than 3.0 cm was that of a hatchling. Unfortunately, the 1971 hatch was very low and these data were disregarded.

Results

The transect data are summarized in Table 1. The distribution between diurnal and nocturnal activity was significantly different for adults and juveniles (*Chi-square* 15.84, $P<.001$). The juveniles were proportionally more active during the day than adults were. This distribution was not the result of a difference in total general activity between the two age classes. The age distribution of toads as determined by transect crossings was not different from the age distribution as determined by a separate sample of 152 toads captured and measured throughout the summer from May 5 to August 31, 1971. This sample was part of a general study of toad activity (FitzGerald 1972). One hundred and five toads were adults (69.0%) and 47 were juveniles (31%). Adults accounted for 71% of the total crossings and juveniles for 29%. This distribution was not significantly different from those determined by transect crossings.

TABLE 1 —Number of diurnal and nocturnal crossings of adult and juvenile toads between June 6 and August 31, 1971

	Diurnal	Nocturnal	Total, 24 hours
Adults	21	788	809
Juveniles	52	280	332
Total	73	1068	1141

Adjusted *Chi*-square 15.84, 1 df, $P < .001$

One problem with our technique of classifying toad tracks must be mentioned. Some toads classified as adults may have been large juvenile females (i.e., approximate snout–vent length of 5.0–6.5 cm). But if these juvenile female crossings were excluded from adult data, the difference in distribution between diurnal and nocturnal activity would probably be increased, not decreased.

Because immature toads grow rapidly in a single season (Hamilton 1934) the possibility of changes in diurnal activity throughout the season was considered. The period of data collection was divided into three intervals: June 6 - July 4, July 5 - August 4, and August 5–31. The seasonal change in porportion of toads active diurnally is given in Figure 1. In all three periods juveniles showed greater diurnal activity than did the adults.

Discussion

We have observed juveniles and hatchlings on the sand transect at mid-day when temperature and humidity conditions were not favorable for adults. Aschoff (1964) has discussed the possible survival value of daily activity rhythms. He thought that such rythms provide a means by which different stages in the life history of a species may be accommodated in one environment without competition if their rhythms are out of phase. Wynne-Edwards (1962) also presented evidence that different age groups of a species vary in their temporal distribution, thus reducing competition and cannibalism. Large *Bufo americanus* will cannibalize smaller ones (personal observation). Also it is known that large adult green frogs (*Rana clamitans*) and leopard frogs (*Rana pipiens*), when kept in captivity, will displace smaller conspecifics from a food source (Boice and Williams 1971). This is also true for *Bufo americanus* kept in outdoor enclosures (FitzGerald 1972). Reasons for relatively greater diurnal activity of juveniles are speculative, but we suggest that a reduction in competition for insect food and avoidance of contact with adults may be advantageous, particularly in years of high population density and size.

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FIGURE 1. Seasonal change in proportion of toads diurnally active. The number above each bar is the total of diurnal and nocturnal activity records.

rainy nights. This manuscript has benefited from the criticisms of D. Hay, J. Harwood, and Professor M.H.A. Keenleyside.

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Observations of the Marten, *Martes americana*, in the Mackenzie District, Northwest Territories

Opportunities for observation of martens in the field occur infrequently. We were fortunate to make extensive observations of four martens in the immediate vicinity of Heart Lake Biological Station (Mile 81, Mackenzie Highway), Northwest Territories, between September 1973 and May 1974.

The station is located above a substantial escarpment and is bordered on one side by an extensive system of limestone crevices along the upper edge of the escarpment. Vegetation is relatively sparse, with jack pine (*Pinus banksiana*) and white spruce (*Picea glauca*) dominating the canopy, and juniper (*Juniperus communis*) dominating the shrub layer.

Martens have been seen around the station for a number of years. The availability of supplemental food, the proximity of suitable habitat, and the marten's insatiable curiosity seem largely responsible for their presence. Four martens were observed on numerous occasions throughout the 8-month period. With some practice individuals could be distinguished by their size and pelage. Size difference between the sexes is not necessarily great, but is sufficient to distinguish male and female when sighted together. This allowed us initially to identify two males and two females. Variation in winter pelage ranged from very dark brown to a fawn color. Facial coloration was ash gray in three animals and dark brown in one. The pale buff chest patch varied in size and intensity of color.

Individuals were sighted most frequently alone or in pairs. On several occasions three animals were seen together. Although all four animals were never seen simultaneously, often they all visited the same location within a single day. While every other combination of the four individuals was seen at least once during the year, one male-female pair appeared most frequently.

Intraspecific aggression was noted only in the proximity of food. This usually involved growling and baring of teeth, followed by a chase of several feet. No actual physical conflicts were observed. Aggressive incidents in the predominant male-female pair were

most common, and were usually initiated by the male. One incident initiated by the female of this pair toward the second male, and one incident between the two males were also recorded. Usually, the two males tolerated one another's presence within several feet. No aggressive incidents involving the second female were observed.

Social behavior in martens is poorly understood. Most information is based on captive individuals (Markley and Bassett 1942; Remington 1952) or ranch-raised stock (Hurrell 1968). Although the animals we observed were given supplemental food, the quantities provided probably represented only a small fraction of the animals' total diet. We feel that our observations more closely approximate a natural situation than most other observations.

Most sightings of wild martens have involved single individuals, and it was once widely believed that the marten was generally a solitary animal (de Vos 1951). Hawley and Newby (1957) have shown that adult animals will tolerate the presence of sexually immature animals within the adults' home range, but they observed social tolerance in adult males and females only during the breeding season, and in females and young only during the period of juvenile dependency.

From our observations, we feel that the predominant male and female were adults. The male had been observed in the area during the two preceding summers and one preceding winter. The female had been seen during the preceding summer. Neither the second male or female had been observed prior to mid-autumn 1973.

An autumn scat collected from a nearby crevice contained a marten premolar tooth, probably ingested during feeding. It seems likely that this was a milk tooth from an animal born earlier in the same year. If this is the case, one or both of the second pair could have been offspring of that year. Alternatively, these animals could have been sexually immature yearlings from a previous litter. In any event, the social tolerances exhibited by the four animals strongly suggest a family relationship of some sort.

Animals of both sexes were observed urinating and scent marking in the immediate vicinity of the station. Urination was ordinarily accompanied by a rhythmical lateral undulation of the hips, and usually occurred along runs in the snow or in areas where food was obtained. Scent marking involved the dragging of the abdominal scent glands across the ground or some other surface, and usually occurred near food sources and around the buildings at the station. But one incident of scent marking by a male was observed along the snow surface in an open area adjacent to the station.

The element of cover appeared to have an important influence on behavior. Individuals travelled swiftly through open areas, and tended to concentrate their activity in areas where cover was present, or nearby. The crevice system adjacent to the camp was used heavily by all four animals throughout the period of observation. The martens created numerous runs along the snow surface in and between the crevices and camp. They also maintained several snow tunnels similar to those described by Murie (1961). Artificial cover (buildings, tent platforms, etc.) was heavily utilized in the camp, and access routes to such cover were quickly reopened after new snowfall.

Cover obviously provides protection from aerial predators. Martens in this area are probably vulnerable to predation by Great Horned Owls. This was certainly suggested by our observation of the small female marten repeatedly darting for cover when crossed by the shadow of a raven flying overhead. Although she might simply have been more aware than the others, this particular animal had a large, well-healed flank wound, which might indicate a previous encounter with a raptor.

It has been suggested by de Vos (1951) and de Vos and Guenther (1952) that the arboreal habits of the marten may have been overemphasized in the past. Our observations agree with this, as we saw little arboreal activity. One individual, however, did occasionally display a propensity for climbing and leaping from heights of up to 10 feet, often landing as much as 9 feet from the base of the tree. As it was often done for no obvious reason, this behavior could possibly be interpreted as play activity, a phenomenon well established in other members of the Mustelidae.

It was difficult to detect any strict daily pattern of activity. Daytime activity seemed to increase toward mid-winter with the decrease in day length and maximum light intensity. As spring approached, individuals were observed less and less frequently during the day. The martens remained active during periods of extreme cold (−40°C) and heavy snowfall. They were also observed during light and moderate rainfall. Occasionally, all four individuals would disappear from the area for several days. These absences increased in both frequency and duration toward the latter part of March. The predominant male and female usually reappeared before either of the other two individuals, but were sighted together less frequently as spring approached. By the end of April the second male and female seemed to have left the area entirely. This would tend to support our suggestion that these two animals had been immature offspring of the predominant pair.

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Photographic Records of Predation at Lapland Longspur and Snow Bunting Nests

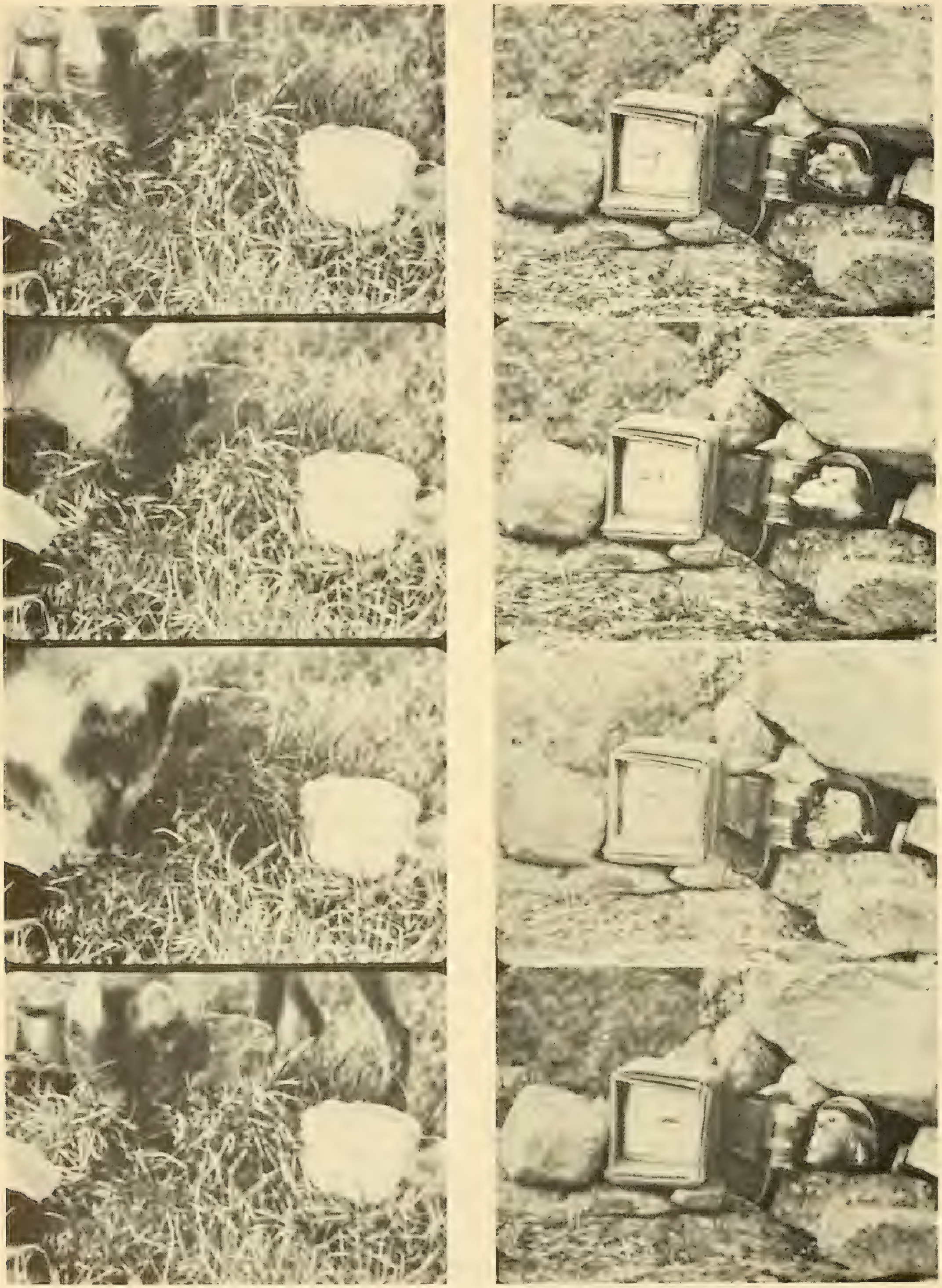
Abstract. Predation of Lapland Longspur and Snow Bunting nestlings by arctic fox and short-tailed weasel was photographed automatically by cameras placed at nests to record bird activity.

Fieldworkers studying breeding biology of birds often find high rates of predation at nests, but usually the identities of the predators must be inferred because they are rarely observed taking the nest contents. Recently Custer (1973) recorded predation by a Snowy Owl (*Nyctea scandiaca*) of nestling Lapland Longspurs (*Calcarius lapponicus*) by time-lapse photography, and Barkley (1972) observed predation by a short-tailed weasel (*Mustela erminea*) and a garter snake (presumably *Thamnophis sirtalis*) at nests of Ruffed Grouse (*Bonasa umbellus*) and American Goldfinch (*Spinus tristis*), respectively, by means of closed-circuit television. While the behavior of the predators may have been influenced in some way by the proximity of the recording apparatus, these records provide unusual instances in which predation was observed undisturbed by human presence, and prompt me to place on record similar observations at Snow Bunting (*Plectrophenax nivalis*) and Lapland Longspur nests.

In the course of studies of birds on the Truelove Lowland (75°40′ N, 84°35′ W), Devon Island, Northwest Territories (Hussell 1972; Hussell and Holroyd 1974) in the summers of 1966–1969, I placed cameras at several Snow Bunting and Lapland Longspur nests to record activity patterns of adults feeding young. The birds photographed themselves (and a clock placed nearby) on a frame of 16-mm Kodachrome movie film each time they visited the nest. The camera shutter operated when a microswitch was closed by the birds' standing on a perch placed at the rim of the nest for longspurs or at the nest cavity entrance for buntings. Because many nests were lost to predators in the first two years, I attempted to protect Snow Bunting nests which I wished to use for experimental purposes in 1968 and 1969 by placing rocks around the entrances of the nest cavities, making them inaccessible to arctic foxes (*Alopex lagopus*). For recording visits at bunting nests in 1969, I used a specially designed entrance hole with a built-in perch, placed so that it formed the only access route to the nest for the adults (see Figure 1b).

Cameras at one longspur nest and three bunting nests were operated by predators as well as by the adult birds, while young were in the nest. A predator was photographed at a fourth bunting nest after the young had fledged successfully. Details of the activities of predators at these nests are given below.

Lapland Longspur Nest Number 27/1967. On 18 July 1967 the nest contained six young estimated to be 5–7 days old (ages vary because the eggs hatch asynchronously). The camera recorder at this nest was probably not functioning perfectly, but the first visit by the adult female after the night rest period was recorded at 0350 (all times are given as Mean Solar Time) and 12 visits by both adults were recorded by 0503. The next 12 photos show an arctic fox at the nest from 0539 to 0547 (Figure 1a). In several frames the fox has its muzzle in the nest. After the departure of the fox, the adult birds continued to visit the nest for several hours, sometimes carrying food in the bill. Six visits were recorded between 0603 and 1157. When I checked the nest at 1415 it was empty and showed little sign of disturbance.



Snow Bunting Nest Number 23/1967. The nest was in a cavity under a large boulder with another rock lying against it. On 30 July it contained five banded young, whose ages at the time of the predator's visit on 31 July were estimated as 10.2, 10.2, 10.0, 9.2, and 8.1 days. On the morning of 31 July the adults were recorded visiting the nest regularly until 0637 for the male and 0656 for the female. Between 0700 and 0703, 16 photos show an arctic fox at the nest, often with its head deep in the entrance of the nest cavity. There was no record of subsequent events at this nest because the two perches and microswitches (connected in parallel for operating the camera) were apparently pulled out of the nest entrance by the fox in its attempts to reach the young. At 1650 the four oldest young were still present and they later fledged successfully, but the youngest nestling was missing. I assumed that it had been taken by the fox.

As I have pointed out elsewhere (Hussell 1972), young Snow Buntings about 10 days old tend to move out of the nest into the recesses of the nest cavity when disturbed. The smallest young (8.1 days old), however, would have been less advanced than the others in this respect, and may have crouched in the nest and remained accessible to the fox.

Snow Bunting Nest Number 27/1969. On 25 July this nest contained seven young, 9–11 days old (the brood had been increased from six to seven on 18 July, for experimental purposes). Male and female adults were recorded visiting the nest regularly until 0735 and 0713, respectively. The next four frames of film each show a short-tailed weasel leaving the nest entrance with a young bunting in its jaws, at 0755, 0805, 0851, and 1436, respectively (Figure 1b). Of interest here is the long period of predatory activity (at least 6 hours and 41 minutes) and the absence of any further evidence of adult buntings visiting the nest. It is not clear whether the same weasel is involved in all four records. In the early afternoon a group of at least four weasels was observed in the vicinity, one of which was carrying a young bunting from this nest. It is also curious that there is no record of a weasel entering the nest, which suggests that it (or they) either entered by another route or jumped over the perch. When I examined the nest at 1650 one dead young (the oldest) remained in it.

Snow Bunting Nest Number 31/1969. On 24 July this nest contained six young, which presumably were all still present on the night of26–27 July, when they would have been 11–13 days old. Male and female adults were recorded visiting the nest on 26 July until the start of their night rest periods at 2046 and 2039, respectively. It was an overcast night with unusually low light intensities. Between 0013 and 0023, 18 frames of film were exposed, but nothing can be identified on them except the face of the clock. From 0038 to 0039 nine more frames were exposed, of which seven clearly show a short-tailed weasel at the nest entrance, as do eight additional frames from 0049 to 0054. At 0206 the adult male bunting appeared at the nest entrance. Between then and 0538 it was recorded five more times, sometimes apparently entering the nest cavity and then leaving with food still in its bill. Between 0543 and 0605, 19 frames record a weasel either entering or leaving the nest cavity. In none of the photographs taken at this nest is there any sign of the predator carrying dead buntings. When I visited the nest at 1400 it was empty except for the legs (with bands) of one of the nestlings. The young were old enough that some may have escaped, but there is no evidence that they did so.

Snow Bunting Nest Number 30/1969. The photographic record at this nest provides an interesting history which suggests that weasels may locate nests at least partly by scent. The nest contained four young which were 14 days old on 30 July. There is every indication that all fledged successfully, as several frames show young leaving the nest between 0352 and 0429 on 30 July, after which there is no further record of bird activity. At 1640 I confirmed that the nest was empty, but having no immediate use for the camera elsewhere I left it set up at this nest for several more days. Subsequently there were 25 photos showing a weasel entering or leaving the nest cavity. The dates and times of these visits are not known precisely, but they occurred in three groups, at least 16, 24, and 33 hours after the young left the nest.

More than 50% of the "unprotected" Snow Bunting nests found on Devon Island (1966 and 1967) were lost to predators (Hussell and Holroyd 1974). The only direct evidence of the identity of the predators is provided by the photographic records. Nearly all bunting nests, however, were inaccessible to potential avian predators, which include Parasitic and Long-tailed Jaegers (*Stercorarius parasiticus* and *S. longicaudus*), Glaucous Gull (*Larus hyperboreus*), Snowy Owl, and Common Raven (*Corvus corax*). Weasels were seen only in 1969, when lemmings (*Dicrostonyx groenlandicus*) were abundant, and were probably of minor importance in other years. Foxes were present each year and many bunting nests were pulled or dug out of the nest cavities in a way that strongly suggested their work. Placement of rocks around nest entrances in 1968 and 1969 usually prevented these losses. Weasels probably took the young from one other nest in 1969, in addition to the two which were photographed, but the bulk of the evidence indicates that foxes were the main predators on bunting nests.

Predators took about 80% of the Lapland Longspur nests found on Devon Island (Hussell and Holroyd 1974). The exposed nests of longspurs are readily accessible to avian predators, as well as to foxes and weasels. Eggs or young disappeared from many longspur nests without any signs of disturbance. Avian predators, especially jaegers, may have been responsible for some of these losses, but the fox photographed

FIGURE 1. a (left). Arctic fox at Lapland Longspur nest Number 27/1967. The four frames were exposed in quick succession (from top to bottom). The nest is immediately below the fox's head in each frame. Objects at upper and lower left are part of the perch-microswitch apparatus. Clock at right records local time.

b (right). Short-tailed weasel carrying young bunting at entrance of Snow Bunting nest Number 27/1969. Nest was located deep beneath the boulder at upper right.

taking longspur nestlings did so without disarranging the nest. Contents of pellets showed that Parasitic Jaegers took many longspurs and buntings (Hussell and Holroyd 1974), but they appeared to be mainly fledglings, and nestling buntings were usually inaccessible to jaegers. The evidence for Snow Buntings indicates that arctic foxes were important nest predators, and I suspect that they were also responsible for most of the predation at Lapland Longspur nests on Devon Island.

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HARRISON FLINT LEWIS, 1893–1974

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Dr. Lewis was born on December 15, 1893 at Sag Harbor, Long Island, New York State. His father, a native of Yarmouth, Nova Scotia was rector of the local church, and his mother was a daughter of a previous rector. Dr. Lewis was the eldest of seven children. At an early age he developed a deep interest in birds, stimulated, he said by the gift, when he was 3 years old, of a subscription to the magazine *Birds* from his grandfather. In addition to his interest in birds, Dr. Lewis as a boy fished, dug clams, caught crabs picked wild berries, and was exposed to much natural history. He early developed a liking for, and familiarity with, water and acquired his first sailboat at age 14. When he was 15 he spent a summer at Yarmouth in his father's boyhood home and came under the influence of a school principal with an interest in natural history. Already familiar with much of the natural history there, he moved back to Yarmouth in 1911 with his family. In 1912, he began subscribing to ornithological journals beginning with *The Auk* and *Bird Lore*. His interest in ornithology was heightened by meetings with ornithologists of note. He was elected an associate member of the A.O.U. in the autumn of 1912. While he was a student at Nova Scotia Provincial Normal College, he reported the first evening grosbeak record for Nova Scotia.

His first publication was a note about the grosbeaks in *Bird Lore* in 1913. After a couple of years of school teaching in Nova Scotia he entered Acadia University, as a sophomore in the fall of 1914. He graduated with a B.A. degree in 1917. His education was interrupted by service in the First World War. After the war he worked as a civilian auditor in the Department of Militia and Defense at Quebec City in 1918 shortly after his first marriage.

While at Quebec City, he used the library facilities of Laval University to build up his knowledge in ornithology while continuing his field observation of birds in the Quebec area. He familiarized himself in a relatively short time with developments in ornithology in North America from 1876 to 1911, as represented in the published work in that library. That was a turning point in his career. Without that background knowledge of ornithology he would not likely have qualified for the position he entered in the federal government service. Dr. Lewis accepted the position of Chief Migratory Bird Officer for Ontario and Quebec on November 1, 1920. In 1921 his headquarters changed from Quebec to Ottawa. The position was in the Dominion Parks Branch of the Department of the Interior. Dr. Lewis served throughout the provinces of Ontario and Quebec from 1920 until 1944. His knowledge of boating was helpful in his long boat-patrols of the north shore of the gulf of the St. Lawrence River. Among other important work he developed a system of migratory-bird sanctuaries along the north shore of the Gulf of St. Lawrence and in James Bay, which have maintained bird populations that would otherwise have declined. During that 24-year period, he travelled widely to meet and address the public, and to carry out enforcement of the migratory birds regulations as well as to conduct scientific research and gather information for management of bird populations. He played a very active role in the annual revision of the regulation under which migratory birds were hunted throughout the area. That required a broad knowledge of the whole area (1/4 of Canada) and of its bird populations and the timing of their movements. Dr. Lewis spent a year at the University of Toronto in 1925–1926 to secure his Master's degree. His thesis was "A Distributional and Economic Study of the European Starling in Ontario." Dr. Lewis registered at Cornell University as a graduate student in 1926, and his thesis, "The Natural History of the Double-crested Cormorant,"was prepared under the chairmanship of Dr. A. A. Allen. He attended Cornell during the Academic year 1928–1929 and received his Ph.D. degree in 1929 while on leave without pay, from his government duties.

In 1944 Dr. Lewis assumed the position of Superintendent of Wildlife Protection for Canada — the head of the agency he had joined in 1920. With increasing knowledge and increasing human population, the work of the agency had been

Harrison Flint Lewis

Photograph taken during Dr. Lewis's tenure as chief of the Canadian Wildlife Service 1947–1952.

supplemented by wildlife research and management other than ornithology at the request of other government agencies, and also was to provide cooperation with provincial and territorial governments. By 1947 the agency became known as the Wildlife Service. At first it was called Dominion Wildlife Service, but as the term Dominion was falling into disrepute it was soon changed to Canadian Wildlife Service. Dr. Lewis was the first Chief of the Canadian Wildlife Service. At its beginning on November 1, 1947 it was a small unit. It is now the well-known national agency working in the wildlife field throughout Canada. It is known throughout the world for its involvement in multi-national wildlife programs. Dr. Lewis headed the service through its formative period from 1947 to 1952. On April 1, 1952 he left the public service of Canada.

Dr. Lewis' international work was exemplified by long membership in the International Association of Game, Fish and Conservation commissioners, by his presidency in 1949–1950, and by his involvement in several of its committees for many years. His initiative in new developments was illustrated by the creation, at his urging, of a National Research Council Associate Committee on Wildlife Research of which he was the first chairman in 1947. The work of that committee did much to stimulate an expansion of wildlife research in Canadian universities.

Throughout his long career Dr. Lewis published reports and articles on his work; they cover the period from 1913 to 1973, and deal with a wide range of subjects from new species records through losses of birds at lighthouses to recommendations for airport management to reduce bird hazards to aircraft.

His life-long interest in ornithology led him from an associate membership in the American Ornithologists' Union to a fellow and council member of that organization. He served also on local and regional naturalists' organizations and was sometime editor of *The Canadian Field-Naturalist* (Volume 36(1), 1922 to Volume 39(4), 1925) and *Sportsmen's Province*. At his death he was a charter member and former president of both the Nova Scotia Bird Society and the Nova Scotia Resources Council.

From 1952 until his death on January 16, 1974 he lived in West Middle Sable and later Sable River, Nova Scotia. Those communities are near where he spent some of his youth. After his retirement from the government service, he made studies, under contract, for provincial and federal government agencies. For his last eight years he was a valued member of the Associate Committee on Bird Hazards to Aircraft of the National Research Council of Canada. As a contractor working on behalf of the Committee he personally examined more than 40 airports, mainly in Eastern Canada, provided detailed information on the bird problems, and made recommendations for changes to reduce them. Many recommendations were put into effect to increase flight safety.

While in charge of the Wildlife Service and afterward, Dr. Lewis had a strong influence on the biologists with whom he came in contact. He was always well-informed and precise and was an excellent writer and editor. Many of us, including the author, learned a great deal about research methods, research reporting, and the use of the English language, under his kind but firm instruction. The ieas he left behind and the habits he helped many of us to form, will ensure that for a long time he will be in our minds as a great leader, encourager, and example.

Dr. Lewis was aided throughout his work by the women at his side. He first wife, Blanche, died in 1944. She was the mother of his three children, two sons, Barnard and Clarke, and his daughter Betty (Mrs. Robert J. Dingwall). His second wife, Laura, was his constant companion from 1945 until her death at Sable River in the 1960s. He is survived by his children mentioned earlier, 12 grandchildren, and his third wife, Elizabeth, who continues to live at Sable River.

Editor's Note: Dr. Harrison Flint Lewis was made an Honorary Member of The Ottawa Field-Naturalists' Club on 13 March, 1952. He had been a member of the club since 1919. In addition to his many accomplishments and interests noted by Dr. Solman, the following information was supplied by Dr. Phyllis R. Dobson of the Nova Scotia Bird Society.

Dr. Lewis wrote more than 300 articles, some scientific, others of more general interest, for such periodicals as *The Canadian Field-Naturalist*, *The Auk*, *Bird Lore*, *Bird Banding*, *The Condor*, *Rod and Gun in Canada*, *The Wilson Bulletin*, etc.; and he completed, in 1973, a History of the Canadian Wildlife Service, a work of 125,000 words, writ-

ten at the request of the Canadian Wildlife Service, but which is not yet published.

He served as President of the International Association of Game, Fish and Conservation Commissioners in 1950, and became Honorary Life Member of this association. Among his many affiliations in this field were The Wildlife Society, the Quebec Society for the Protection of Birds, the Society of Sigma Xi, Canadian Society of Wildlife and Fishery Biologists (now Canadian Society of Environmental Biologists), National Audubon Society, Massachusetts Audubon Society, Canadian Nature Federation, and the American Ornithologists Union. He was, more than any other individual, responsible for the founding of the Nova Scotia Bird Society, and the Nova Scotia Resources Council.

Dr. Lewis received an honorary degree from Acadia University in 1955.

Dr. Lewis was a member of the National Research Council's Associate Committee on Bird Hazards to Aircraft. From 1964 to 1968 he inspected airports for this committee. This led to his being involved in research work carried on at Acadia University in regard to alternative vegetative cover for airports. He had just completed this assignment a short time before his death.

In his high uncompromising standards, complete honesty and capacity for thorough conscientious work, he had few equals in this or any other time or place.

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News and Comment

Association of Systematics Collections

Abstracts from the Annual Meeting Symposium
"The Applications of Systematics Collections to the Needs of Science and Society."*

Systematics Collections — An Essential Resource in Environmental Assessment

By J. Frances Allen

Systematics collections, the very basis for understanding the environment and thus the essential resource in environmental assessment, offer a potential versatility not yet fully recognized nor appreciated by those who have the greatest need. Correct identification of organisms is critical and must include organisms used in bioassays, in experimental investigation of a single pollutant or pollutants on individual species or on combinations of species, as well as biota of the natural environment, of the so-called unaltered environment, and of the stressed environment. Included are those organisms from the smallest ecosystems of experimental aquaria to the diverse natural terrestrial and aquatic ecosystems. The distressing lack of appreciation of systematics, the inexperience of workers on environmentally associated problems, the lack of emphasis on accuracy of identification, and the incompleteness of information are very real. Systematics collections are the source of the required baseline data. Collections in museums and herbaria as reservoirs of data on rate and magnitude of environmental changes in ecosystems are a demonstrated fact. Collections should include data on chemical analyses and information on associated environmental parameters as well as systematics data. Development of new forms of indices relevant to evaluation of impact of multiple sources of environmental stress is requisite for assessment. Present guidelines for preparation of environmental impact statements fail to require the following: critical authoritative identifications of biota, validations of analyses, deposition of voucher specimens, planned procedures for permanent storage or for data retrieval, assurance that individuals preparing environmental impact statements or providing information are knowledgeable of biological communities and ecosystems and appreciate the value of fossils and stratigraphic materials.

Users must recognize that without collections, associated systematics and ecological data, and without systematics services, understanding the many facets of the environment and evaluation of impact of environmental alterations are impossible. Decision makers must become cognizant of these collections as data bases, and of their significance for understanding the environment. Decision makers must appreciate their value in interpretation and prediction of environmental change.

Environmental assessment is the concern of all society. Now is the time to convince the engineering and the scientific communities, the public, the agencies, and the Congress that without systematics collections there is no environmental assessment.

Needs for Systematics Facilities in Applied Ecology

By Jon Ghiselin

Applied ecologists especially need inclusive biological surveys of areas typical of sizable regions. Because such surveys are costly and difficult to carry out, they have rarely been attempted and more rarely completed. But orderly organized biotic inventories are essential for assessing probable environmental impacts of proposed developments. In the absence of modern regional surveys, the applied ecologist must undertake local inventories himself and his clients must pay for them.

Any controlled biotic assessment generates specimens which usually must be both identified and stored. Applied ecology requires both taxonomic specialists and systematic collections. If identification is deferred against a later need, its cost is that of storage. Immediate identification reduces storage requirements, but at the cost of hiring specialized help, and still requires retaining vouchers.

Museums must be used in identifications. Satellite museums can only reduce the demand on established facilities. Repositories for vouchers should be near enough to major collections for identifications to be checked and the specimens used in taxonomic work.

Museum technicians are needed by both ecological consulting firms and specimen repositories. They should be trained in university and other museums. Systematists wishing to do practical taxonomic work should organize to be easier to find. Museum representatives can aid ethical applied ecologists in acquiring specimens, and still not compromise their own non profit status, by agreeing to the deposit of specimens in their collections.

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Environmental Protection: A Legitimate Focus for Systematics Institutions

By Howard S. Irwin

The problems confronted by a systematics institution are an aspect of the search for the keys to human survival; the search demands uncommon thinking, and is thus man's greatest challenge. Our focus must be broad if we are not to become captive to the constraints of institutional tradition, blinded by inter-institutional one-upmanship, lost in regional provincialism, or swept up by national hubris.

The complexities of our time include sweeping quantitative and qualitative changes that transform everything. The man-made world has now spread all over the planet, displacing and subjugating the natural world. Human institutions and the art of government were designed for simpler tasks, and are no longer able to cope. The snowballing mass of changing, intertwining problems is so basic and critical that it is impossible to isolate any major issue or to deal with economic, demographic, ecological, educational, or political problems separately.

The cause of these complex problems is the exhorbitant power suddenly acquired by man. The shift of the power balance from nature to man is backfiring because of the tremendous mismatch between man's newly acquired might and his capacity and willingness to control it.

Reliance on past solutions to problems is misleading; a new philosophy of life must be devised. Only a profound change of values and norms matching the scientific, technological, and industrial revolutions can re-establish man's inner balance and set society on a sane course. Systematics collections can occupy an important position in the scheme of this course.

The stance of systematics collections before today's challenge of environmental protection encompasses their positions as treasuries of research data and adjuncts for student training. In some, the professional staff serves a review function, evaluating the adequacy, accuracy, and interpretation of systematic data in reports, impact statements, and projections. In a few institutions, the systematics staff has entered into the arena of environmental protection.

In any degree of involvement in preservation of the natural environment, we must take advantage of our institutional flexibility to embark on a newly disciplined step-by-step approach toward solutions that, through this flexibility and openness, avoid the dangers of institutional bias. Our ultimate goal is to see men and women think of themselves as human beings, heirs of the earth and masters of all machines.

Grant to Encourage Arctic Reserves

"Arctic Ecological Reserves" is the title of a readable and attractive booklet arguing the importance of setting aside unique samples of our northern wilderness. These reserves would serve several puposes: provide untouched areas for long-term study, protect endangered species of wildlife and plants, and provide a genetic pool to replace animals and plants which have disappeared from areas affected by man's activities.

White Owl Awards Committee member Dr. Adrian Jones presented a cheque for $1,500 to Dr. Everett Peterson in Edmonton on 20 August, 1974, to reprint the book and make it available to those interested in the establishment of Arctic reserves.

The publication is the result of research done by Panels 9 and 10 of the Canadian Committee for the International Biological Programme. The I.B.P. is a world-wide UN–sponsored program of which the conservation of "terrestrial ecosystems" is an important activity. Canada was divided into 10 regions, with a consulting panel of scientists in each, for the purpose of identifying potential ecological reserves.

Panels 9 and 10, which studied the Arctic, were made up of experts in plant and animal ecology, wildlife management, fisheries science, forestry, geography, plant taxonomy, soil science and geology.

These scientists have identified and mapped areas of particular ecological value which should be preserved, working with native peoples, and cooperating whenever possible with extractive industries to establish optimum land use and management plans.

Potential reserves have been classified according to ecological features and degree of protection required. Not all of the reserves need be completely out-of-bounds for certain commercial activities, and in some, modified techniques would be monitored for the guidance of both industry and those responsible for the area's management.

Dr. Peterson, who heads Panel 10's activities, summarizes: "This is a Canadian attempt at setting aside areas that are clearly not only of national but of international significance to science, to conservation, and to education in the broadest sense." Now it is up to the Ministers of Indian and Northern Affairs, and Environment to present the legislation which will make Canada's Arctic Ecological Reserves a reality.

Environmental Conservation — A New Journal

Elsevier Sequoia SA (Lausanne, Switzerland) and the Foundation for Environmental Conservation (Geneva, Switzerland) announce the publication of a journal entitled *Environmental Conservation*. With the collaboration of the International Union for Conservation of Nature and Natural Resources (IUCN), International Conferences on Environmental Future (ICEF), World Environment and Resources Council (WERC), and with the support of the World Wildlife Fund (WWF), the journal advocates action for the protection and amelioration of the environment of living things, including man.

Environmental Conservation will act as the much-needed forum for all scientists devoted to maintaining global viability through exposing and countering environmental deterioration resulting from human population pressure and unwise technology.

Founder-Editor Prof. Dr. Nicholas N. Polunin of the journal will be supported by thirty-five Advisory Editors covering between them all subject areas concerned with the maintenance of viable ecosystems.

Topics will range from pertinent case histories of the past and present to rational use of resources, foreseeing ecological consequences, enlightened environmental policy, anti-pollution measures, low-impact development, environmental education and law, and ecologically sound management of all land and fresh water, sea, and air.

Environmental Conservation will be published quarterly. The publishers address is Elsevier Sequoia S.A., P. O. Box 851, CH–1001 Lausanne 1, Switzerland.

Symposium on Wildlife in Urban Canada May 26 - 30, 1975 University of Guelph, Guelph, Ontario

A symposium on "Wildlife in Urban Canada" is planned to bring together specialists interested in the problems and challenges of wildlife in urban areas. Workshop sessions on the theme, panel discussions and presented papers will form part of the overall program.

For further information and program outline, contact the Office of Continuing Education, University of Guelph, Guelph, Ontario.

Notice

To Individual and Family Members Not Resident in the Ottawa Area

Trail & Landscape is a non-technical publication of The Ottawa Field-Naturalists' Club. It includes articles on Ottawa-area natural history as well as Club news items. It will be sent to you at no cost if you request it in a letter to The Ottawa Field-Naturalists' Club, Box 3264, Postal Station "C", Ottawa, Canada K1Y 4J5. *Librarians should note* that this does not apply to institutional subscribers.

Book Reviews

Zoology

Grzimek's Animal Life Encyclopedia

Edited by H. C. B. Grzimek. 1972. Volumes 7 (Birds, 1; 579 pp.), 8 (Birds, 2; 620 pp.), and 9 (Birds, 3; 648 pp.). Van Nostrand Reinhold, New York. $25.00 per volume.

Grzimek's Animal Encyclopedia treats both the vertebrate and invertebrate animals of the world in 13 volumes. The three volumes dealing with the birds are here reviewed.

Volume 7 opens with an introductory section (pp. 17–80) on general aspects of birds. It presents information on such well-chosen subjects as avian anatomy, flight, migration, plumage, color, behavior, reproductive cycle, and primitive birds. The text is generally accurate and not too technical.

The bulk of the three volumes is a presentation in phylogenetic sequence of pertinent information on the world's bird life. Each chapter is a unit devoted to one or more order or family and the contained species. The text is written by various ornithologists. Interesting facts are given on the major groups as a whole and treatment then progresses down to and through the species within the group. Descriptive material is of necessity brief but pertinent, and in addition to the appearance of the bird, it includes ranges (often with maps) as well as average measurements and sometimes weights. Care has been taken to provide scientific as well as vernacular names for all of the vast number of species mentioned. Although direct citations to literature are few in the text, there are lists of suggested readings in the back of each volume, to which the reader can turn for amplification of particular points. Volume 7 contains, in phylogenetic sequence, accounts of the birds from tinamous to quails; Volume 8, grouse to pheasants; and Volume 9, kingfishers to and through the vast assemblage of passerines.

All three of these handsome volumes are generously illustrated in color by paintings done by several artists and by color photos depicting in total a large number of species. Also, various principles are illustrated by line drawings and there are a great many small but effective range maps. The paintings, although not great art, are good to fair portrayals of the living bird; a few are less successful. The plate showing the wood warblers is downright poor, the postures of the birds particularly so.

With so many authors, some unevenness of the text is almost inevitable, especially in opinions on systematics. More uniformity might have been achieved in the chapter titles, however, some being given the English vernacular name alone of the higher taxon concerned, others the scientific name, and others a combination of both. In the systematic list, the name of the parrot order is inconsistent in its suffix with treatment in the rest of the orders.

Better editing would have eliminated also some of the typographical errors and misspelled words. 'Audubon' is consistently misspelled three times on one page (Volume 9, p. 623); the symbol indicating endangered taxa is not given although a space has been left for it (9, p. 523, line 3) and National Museum of Canada is given as "Natural Museum Canadian" (9, p. 619).

The important genus *Saltator* of Middle and South America is overlooked in the main text although there is a color illustration of the species *Saltator atriceps* (captioned as an ant tanager, a vernacular better restricted to the genus *Habia*).

The text suffers somewhat from translation into English. For example, anatomical features of birds are given such little-used terms as 'cleft of beak,' 'angle of lips,' 'thumb-feathers,' and 'wing butt.' The Catbird's name is said to be derived from a vocal resemblance to a cat's 'screech' ('mew' would better describe it).

The drawing showing the method of measuring the length of the tail in birds (7, p.18) erroneously indicates the point at the base of the tail where the measurement starts. If followed this would give a highly significant error. In the range map of the Common Loon, Newfoundland is not included although that species is common there.

In the back of each volume there is a systematic classification of the birds included in that volume. Also, there is a dictionary of the English, French, German, and Russian vernacular names, arranged alphabetically. Although this is a useful feature, one wonders if the more than 150 pages it consumes in the three volumes could not have been put to better use. Each volume has lists of supplementary reading as well as a good index of bird names.

Persons requiring reliable general information on the world's bird life will doubtless find what they need in this well-illustrated compendium.

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A Guide to the Freshwater Sport Fishes of Canada

By D. E. McAllister and E. J. Crossman. 1973. National Museums of Canada, Ottawa. 107 pp. $3.75. French edition also available.

This pocket-sized paperback has been written specifically for the angler. By giving the identifying features of those species of fish apt to be taken by anglers, the book should be particularly helpful to the novice fisherman in identifying his catch. General distribution maps for each of presently recognized and potential sport fish will give the angler a good overview of the general Canadian range of the species which he (she) wishes to pursue, but these maps are not in sufficient detail to identify individual fishing waters.

The introductory chapter gives a brief discourse on the nomenclature, structure, biology, and ecology of Canadian fishes, including methods for preserving fish for later identification. The appendices should prove to be particularly interesting to anglers wishing to optimize their enjoyment of fish which have been caught. Topics include the making of fish prints as permanent record of trophy or other fish, and methods of preparing fish for the table. A number of good references are provided for sportsmen and naturalists wishing to know more about the distribution, identification, and bio-ecology of Canadian fishes.

The principal advantage of *A Guide to the Freshwater Sport Fishes of Canada* over other books on Canadian fishes is its compact size and a restriction in data to include only points of interest to the angler. Perhaps appearing overcrowded and congested at first perusal, the value of the book as reference increases as the reader becomes familiar with the format.

The book is undoubtedly a useful and reasonably-priced field guide for the angler. The more serious fisherman, naturalist, or biologist wishing a more comprehensive library reference should, however, purchase as well *The Freshwater Fishes of Canada* (Scott and Crossman) published by Environment Canada, from which most of the information was seemingly abstracted.

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Wildlife Ecology – An analytical approach

By Aaron N. Moen. 1973. W. H. Freeman and Co., San Francisco. 458 pp. $17.50.

For those confronted with the task of teaching wildlife biology or ecology, there have been few texts suitable for such a course. Smith's (1966) *Ecology and Field Biology* came as close as any until Aaron Moen wrote *Wildlife Ecology*. Moen's book is a bit of a misnomer, concentrating on ruminants, and particularly the white-tailed deer. Despite this narrowness of example, the principles delineated are broad enough in scope to make this an extremely useful text. Although one may disagree with the author's crusading endorsement of analytical ecology, and the somewhat pedantic writing style, the end result is still a sound, factual presentation of much of the current biological knowledge of white-tailed deer.

Though there is a step-by-step progression from very basic environmental considerations such as soil, water, and general physiography through to energy relationships, particularly those related to climatic conditions, this is not a comprehensive ecology text. The reader must have a sound background in ecology to fill the numerous gaps left with respect to basic ecological theory. Instead, Moen has concentrated on energy interactions between organism and environment. Ruminant metabolism and nutrition are treated in detail in Part three of this six-part book. The author leans heavily on research done with domestic ruminants. He also allows himself to follow some older unsubstantiated theories of thermal exchange at the body surface. "White coats absorb less and reflect more solar energy" (p. 78). "Many arctic animals are white in winter and dark in the summer, so other factors such as protective coloration must have had a greater influence . . . than did any thermal benefits from color" (p. 294). This is an old maxim which does not hold up under the scrutiny of current physiological studies of arctic species. The hair of the white coats of these wildlife species allows transmission of the radiant energy so that a "green house effect" is created. There is, therefore, thermal benefit to a white coat under such circumstances. Energy metabolism is thoroughly covered and reflects the author's background in this area.

Part four, which examines behavioral factors in relation to productivity, is unfortunately the weakest link. The simplifications necessary to adapt species

behavior to computer analysis do not do justice to this subject area. The section on intraspecific social attachment in wild ruminants is rife with unsubstantiated generalizations, and the section on movement patterns ignores work done in Michigan on yarding behavior of white-tailed deer and states that moose are non-migratory, despite recent work which contradicts this claim. In addition, barren-ground caribou supposedly make use of forested winter ranges, which must be extraordinarily difficult on Baffin Island and the other northern portions of this species' range. Feeding behavior is similarly handled with statements on white-tailed deer, ignoring seasonal shifts which occur in feeding periods and the need of female deer during the latter stages of pregnancy and during lactation for a ready source of water. The reader should also question the statement that moose are quite independent and have little tendency to congregate. Associations of moose during the winter months are not uncommon. If the reader makes use of the extensive reference lists provided at the end of each chapter he should cover many of the errors of commission and omission in this section. The reference lists and the appendices provided are especially useful to the student, and the author is to be commended on their comprehensiveness.

Treatment of the animal as a physical entity occurs in Part five where Moen discusses energy flux and the ecological organization of matter. The animal must be reduced to physical terms so the energy requirements of individuals can be calculated for simulation purposes. The author acknowledges the important role of behavioral adaptations as energy-conserving mechanisms, and chapters 13–15 provide some of the best reading in the book as the author builds his case for analytical studies based on determinations of the energy relationships between organisms and their environment. Yet even here there are minor flaws, as on p. 274: the concept of a thermoneutral zone is called inadequate for ecologists concerned with an animal in its natural habitat, yet the author uses this concept to make several points regarding physiological responses used by animals outside their zones of thermoneutrality (p. 286). Also, white-tailed deer were known to occur in the Atlantic provinces, southern Ontario, up-state New York, etc., prior to the settlement of North America by the white man, yet the author states that the Adirondacks of New York were not inhabited by deer at the time (p. 293).

Two primary concepts are presented by Moen, those of homeothermy and carrying capacity, and *Wildlife Ecology* ultimately leads the reader to computer simulation of the latter based on analysis of the former. The book is often repetitive but this is useful in a student-text. The reader can ignore the egocentric character of much of the text (emphasis on author's own work) and the other faults mentioned simply because this book fills a very real need for teachers of wildlife biology. *Wildlife Ecology — an analytical approach* will serve as a useful text to support the modern concepts of wildlife management based on sound biological understanding of wildlife species.

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Population Ecology of Migratory Birds

Papers from a symposium held at the Migratory Bird Populations Station, Laurel, Maryland, 9–10 October 1969. 1972. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Wildlife Research Report 2. 278 pp.

This volume contains papers given at a symposium to mark the opening of the new bird populations laboratory at the Patuxent Research Refuge in Maryland. The delay of over three years in publication is deplorable, if perhaps typical for multi-authored works as well as for government printing offices. Despite all this delay, the binding is so poor that half the pages of my copy came loose in a single reading; preparation of this review completed the un-binding job. Having registered protest at a slow production and incompetent binding job, I can then say that the contents of this publication deserved better treatment.

Besides the foreword, introduction, and concluding summary, the volume contains ten research papers, most of which will be often cited as source documents in years to come. Only the theme of bird populations is common to all papers, so each demands separate comment.

"Mallard migration corridors as revealed by population distribution, banding and radar," by Frank C. Bellrose (Illinois Natural History Survey), summarizes an enormous body of data on North America's most numerous duck species, in the region through which the highest concentrations pass on their autumn migrations. Bellrose uses "migration corridors" as a term for generalized routes between summer and winter ranges, intermediate in breadth between the now ambiguous term "flyway" and the actual migration path followed by a single flock or group of flocks.

"Aspects of Mallard breeding ecology in Canadian parkland and grassland," by Alexander Dzubin and J. Bernard Gollop (Canadian Wildlife Service, Saskatoon), is concerned with the same species, in its breeding area rather than during migration. Comparisons cover differences between habitats as well as between wet and dry years. Productivity in both areas was insufficient to maintain local Mallard populations without immigration, in the face of losses to hunting in the parkland area and of brood losses in grassland areas.

"British studies of goose populations: hindsight as an aid to foresight," by Hugh Boyd (Canadain Wildlife Service, Ottawa; formerly The Wildfowl Trust, England), discusses population estimates based on counts of wintering geese, and threats to their habitats. These studies cover relatively small total areas, and show frequent anomalies which restrict their usefulness as bases for predicting future population behavior and planning goose management.

"Role of banding data in migratory bird populations studies," by Aelred D. Geis (Bureau of Sport Fisheries and Wildlife, Laurel), deals mainly with waterfowl, although most of the methods of treating data could be used for any bird that is widely hunted. Not all banders, even those employed by government agencies, will agree with Geis' emphasis, which deplores intensive, local studies whose methods and results are not immediately compatible with the pattern here used.

"Some problems in estimating survival from banding data," by L. Lee Eberhardt (Battelle Memorial Institute, Richland), may also be considered as a paper on waterfowl, although no bird species is mentioned. It deals with computer modeling of hypothetical populations under varying harvest levels, a method now being used widely in waterfowl management. I don't pretend to understand it completely; one understandable conclusion is that the relatively simple "life table" analysis of banding data is misleading and not worth continuing.

Turning now from waterfowl, "Population ecology and environmental pollution: Red-tailed and Cooper's Hawks," by Charles J. Henny (Bureau of Sport Fisheries and Wildlife, Laurel) and Howard M. Wight (Oregon State University), explores the influence of toxic chemicals on population survival. Nesting success, shooting pressure, and overall mortality rates are brought together to give a continent-wide picture of declining populations in the Cooper's Hawk, while the Red-tail has remained stable in numbers.

"The importance of movements in the biology of Herring Gulls in New England," by William H. Drury and Ian C. T. Nisbet (Massachusetts Audubon Society), also considers a species which has been greatly influenced by man's actions. The Herring Gull has increased in numbers enormously since persecution lessened after 1880. Both local dispersal and long-range movements have contributed to this population explosion, which is thus not regulated by densities within its breeding colonies.

"Population ecology of the Australian Black-backed Magpie, Royal Penguin, and Silver Gull," by Robert Carrick (University of Adelaide), deals at length with the first species, and more briefly with the others, on the basis of repeated sightings of individually marked birds. These relatively to extremely sedentary birds all exhibit hierarchies, within which only the dominant, territory-holding individuals can breed successfully.

"Influence of territory upon structure and dynamics of bird populations," by Lars von Haartman (University of Helsinki, Finland), considers the limitations to local populations by pre-emption of territorial resources in short supply. Further adaptations include evolution of non-migratory habits and delayed sexual maturity, since older birds and sedentary individuals are better able to secure good territories.

Finally, "The relevance of the mapping census technique to conservation of migratory bird populations," by Kenneth Williamson (British Trust for Ornithology), discusses the use of this technique, developed for population monitoring, in guiding rural land use and forestry practices. Most British birds now found in farmland were originally forest species; land management that continues the present pattern of mixed stands, small woodlots, and hedgerows is much more favorable for birds than plans including large tracts of monocultures, whether of crops or of trees.

Joseph J. Hickey (University of Wisconsin) in summing up, touches on highlights of each paper as well as on themes common to several of them, with comparisons drawn from his more than thirty years in the field of wildlife populations research. His commentary is interesting reading, but it is not and was not intended to be a substitute for reading the other papers, or at least their own summaries. The individual papers range in length from nine to sixty pages, and several are so crammed with data as to offer heavy reading. Only the one on computer modeling is unlikely to be comprehensible to the average person with university education or equivalent interest in the field of bird populations.

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Methods for the Collection, Preservation, and Study of Water Mites (Acari: Parasitengona)

By David Barr. 1973. Life Sciences Miscellaneous Publications of the Royal Ontario Museum, Toronto. 28 pp. $1.50.

There appears to be a growing tendency among amateur naturalists toward an interest in the lesser forms of life. This may stem from an increasing public interest in ecology. Larger forms of life, birds being a prime example, are readily identified in the living state by means of a field guide. Such is not usually the case with the lower forms, some type of preservation being necessary to facilitate identification. In most instances a sample is taken, preserved, and identified at a later date.

The purpose of this small publication is to standardize methods of collecting, preparing, and studying water mites. Anyone who has scooped up a jar of pond water along with some vegetation has probably noticed these mites, often reddish in color and globular in shape, swimming or scurrying about. Included in this booklet are collecting methods for different habitats, hosts, larvae and eggs. Other sections discuss preservation of adults and nymphs; rearing, harvesting, and preservation of larval mites; observations and final storage of skeletal preparations (includes methods of mounting on microscope slides); studies of internal anatomy; scanning electron microscopy; and methods of illustrating the mites. The appendix gives the formulae for reagents used in the preservation of water mites.

The author points out that "the account is directed primarily to those beginning in the field but also to established workers wishing to explore unfamiliar techniques." This publication will prove useful to anyone interested in pursuing studies in freshwater biology.

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Fishes of the Western North Atlantic

Edited by D. M. Cohen. 1973. Memoir of the Sears Foundation for Marine Research, Number 1, Part 6. New Haven. 698 pp. $27.50.

Part six of this magnificent series has now appeared and the quality remains as high as for Part one. Two significant changes in editorial policy, which are radical departures from the tradition of the series, are announced. The series will no longer follow a "phylogenetic" order of publication, and descriptions of new taxa may now appear in the series. In the present volume, for example, diverse groups such as berycomorphs, macrourids, and heteromes are treated, and there are descriptions of two new subspecies, eleven new species, two new genera, and one new family. Both of these policy changes should significantly speed up publication of future volumes. Many of the taxa discussed in this volume are deep-sea forms and have presented numerous taxonomic problems, in part due to the paucity of material available. The present synthesis is, therefore, of considerable value.

The notocanthiforms have long been an ichthyological Pandora's box, and McDowell is to be congratulated on his masterful clarification of their taxonomy. He has added a great deal of new data on the biology, distribution, anatomy, and relationships of the Heteromi, and has interwoven this with an extensive literature review. In the present work, the Heteromi are divided into two suborders, Halosauroidei (one family, Halosauridae) and Notocanthoidei (two families, Notocanthidei and Lipogenyidae). The relationships of the order to the Apodes is defined, and several families previously (at times) associated with heteromes are decisively shown to be unrelated. This treatment will greatly facilitate future work on the group. Keys to all known species are included.

Rosen's treatment of the euryhaline cyprinodontoids is distinctly different from those of other groups. This is warranted because the cyprinodontoids are primarily found in fresh temperate and tropical waters. A key is provided to those species of western North Atlantic Cyprinodontidae, Poeciliidae, and Anablepidae known to be tolerant of saltwater. Notes on range, dispersal, and the relationships of the group are included. Most of the species are illustrated.

The berycomorphs include both deep- and shallow-water forms. This group, like the notocanthiforms, has been fraught with systematic problems, but Woods and Sonoda have laid many of these to rest, e.g., in the genus *Hoplostethus* and the now monotypic *Gephyroberyx*. The higher classification and relationships of the group remain somewhat unsettled, but the reasons for limiting the (extant) Berycomorphi to nine families are clearly outlined. The Antigoniidae are readily (and correctly) dismissed as non-berycoid, but there is no new light on the correct placement of the family(?) Sorosichthyidae.

The Xenoberyces are deep-sea fishes which have not previously been clearly defined in terms of higher

classification. Ebeling and Weed demonstrate that they occupy a position intermediate between the berycomorphs and the cetomimoids. *Gibberichthys pumilus* is retained in the monotypic Gibberichthyidae on the basis of several bizarre characters, and the Stephonoberycidae includes three monotypic genera: *Stephanoberyx*, *Acanthochaenus*, and *Malacosarcus*. This arrangement is admittedly tentative, but because of the paucity and poor condition of available material it is a sound one for the present. The Melamphaeidae, the most speciose of the Xenoberycoid families, has previously been reported in detail by Ebeling (1972, Dana Report 58).

Marshall and Cohen have not included the ophidioids and zoarcoids in the Anacanthini (Gadiformes). This, of course, contrasts with the work of Rosen and Patterson (1969, Bulletin of the American Museum of Natural History 141). The authors believe that the Melanonidae, Eretmophoridae (= Moridae), Gadidae, Steindachneriidae (new family), Merluciidae, Macrouridae, Bregmacerotidae, and Muraenolepidae form "a compact and unique assemblage" to which the ophidioids and zoarcoids may be related but in, as yet, an undetermined way. In my opinion, the case presented by Marshall and Cohen is stronger than that of Rosen and Patterson, but, obviously, these relationships will need more detailed studies.

The Macrouridae are the only anacanthines discussed in detail in this volume. The section has been prepared by Marshall with collaboration in some genera by Iwamoto. The identification of fishes in this family has been a stumbling block to ichthyologists for many years and this synthesis of research and literature clears away many of the problems. A terse section summarizes the knowledge of Atlantic zoogeography of macrourids but also points out that the reasons for the distribution patterns are far from understood. Keys to all known species are included but only those species occurring in the western North Atlantic are discussed in detail.

The series continues to be indispensable for ichthyologists, and the editorial board deserves congratulations for continuing to produce these major works, especially with the problems of co-ordinating many authors. Hopefully, future manuscripts will be published more rapidly so that the literature surveys will not be "dated" when they appear.

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A Symposium on the House Sparrow (*Passer domesticus*) and European Sparrow (*P. montanus*) in North America

Ornithological Monographs No. 14, published by the American Ornithologists' Union. 1973. 128 pp. $3.50 ($2.80 to AOU members).

The A.O.U. series of ornithological monographs, "established for major papers too long for inclusion in the Union's journal, *The Auk*," departed from its usual practice in presenting this issue, a symposium rather than a monograph. This was justified on the grounds that the theme was strongly unified, and that study of these birds would be enhanced by publication of all contributions to the symposium (held on 3 September 1969) in one volume. In fact, this was not done, as three of the 14 presentations have already been, and two more are planned to be, published elsewhere; these are represented here only by abstracts. The introduction states that publication elsewhere had already been arranged when these papers were presented. Since this volume did not appear until 3 1/2 years after the symposium, a fairly typical lag for such compilations, one can hardly blame authors for declining to delay publication, but one wonders what became of the two papers that have still not appeared!

It is my impression that these papers show better what a restricted interest is taken in these species in North America, rather than being a real compilation of what is known about them from studies on this continent. The symposium was chaired and introduced by S. C. Kendeigh who, with his students at the University of Illinois, has for many years used the House Sparrow as a subject for studies of environmental physiology. Other studies reported involved government employees, museum workers, and especially graduate students; contributions by volunteers were lacking.

Chandler S. Robbins discussed the introduction and spread of the House Sparrow in North America. Until 1890 the distribution could be related to expansion from known introduction centers, largely in the east. Later, and in the varied habitats of the west, the spread was less regular, and densities in many western areas are still very low.

Jon C. Barlow reported on the European Tree Sparrow in North America. Introduced about 1870, this species has spread little from its initial area in eastern Missouri and southern Illinois, where it now numbers

several thousand birds. It seems not to have varied significantly in color or measurements from the stock now present in Germany, whence the birds were brought to America.

Richard F. Johnston considered variations in various skull and skeletal measurements in a storm-killed sample of House Sparrows from Kansas. The variations between the sexes differed depending on whether the element measured was involved in food gathering, in sexual selection, or in winter survival.

Mary Heimerdinger Clench's paper on body pterylosis in various *Passer* sparrows is presented in abstract only (see *Auk* 87: 650–691, 1970). She showed that the arrangement of body feathers was uniform, not only between individuals of a species, but for all species and genera of passerine birds studied.

William Klitz presented a summary of protein analyses from serum and tissues of House Sparrows from various North American localities. The birds were concluded to be genetically mono-morphic.

Carl J. Mitchell and Richard O. Hayes described efforts to rear House Sparrows in captivity, for experiments on epidemiology of western encephalitis in northern Texas. The facilities and diet used were satisfactory, although nestling survival could not be compared with natural conditions since most of the young birds were subjected to experimental treatments.

The same authors, with Preston Holden and Thomas B. Hughes, Jr., also studied nesting of House Sparrows in rural and urban habitats near the Texas experimental station. Most breeding statistics established agreed well with those from previous studies, if the southerly location (34°10′ N) was taken into account. More than half of the young in these wild populations were flying before the dates when encephalitis virus was normally encountered in nestlings.

Raymond L. Will reported on a study of House Sparrows in a small town in southern Illinois, in connection with the possible role of the bird in transmitting St. Louis encephalitis. This study also confirmed the breeding parameters and sedentary nature of the species.

C. A. North studied movements of House Sparrows between roosting and feeding areas in and near Stillwater, Oklahoma. Birds reared in the city moved to the periphery whence they foraged in nearby fields during the autumn, and later dispersed. Movements were usually of less than two miles, but some first-year birds moved considerably further (one reached 68 miles).

Carol L. Votava, Elden W. Martin, and John W. Parrish, Jr. described "a preliminary study of the effects of simulated high altitude on the House Sparrow," chiefly in relation to lowered oxygen pressure. The critical partial pressure of oxygen, at which the birds could no longer keep their balance, was much lower than anticipated. (Published here as abstract only.)

S. Charles Kendeigh reported on food intake of House Sparrows under various environmental conditions. Results were published elsewhere (*Comparative Biochemistry and Physiology* 31: 941–957, 1969), and only an abstract is given here.

Floyd H. Blackmore described the energy required for molt in captive House Sparrows under outdoor conditions. The existence energy values found decreased after the molt, presumably owing to improved insulation of the new plumage, to an extent more than compensating for the energy needed for the feather growth. (Published here as abstract only.)

L. Bruce Barnett examined seasonal changes in temperature tolerance of House Sparrows. As expected, birds were least tolerant to cold in late summer and most tolerant in January. Results were already published (*Comparative Biochemistry and Physiology* 33: 559–578, 1970), and only an abstract is given here.

Charles R. Blem explored geographic variation in the bioenergetics of House Sparrows. Birds from more northern areas (Manitoba and Minnesota) tolerated lower temperatures than those from the south. This may be correlated with fat levels more than plumage insulation. At the extreme limits of range (Churchill, Manitoba), the birds probably survive cold periods only by moving inside grain elevators.

The papers above may thus be grouped as follows: five were concerned with the spread of, and possible variations in, two introduced species; three considered a possible carrier of infectious diseases; and five made use of a hardy and easily available experimental animal. Only North's study of movements does not fit clearly into any one of these, although it has indirect connections with the first two groups. It is very doubtful that any of these studies were undertaken from any intrinsic interest in the species—no sparrow lovers, these!

This publication is not likely to inspire people to study House Sparrows as interesting organisms, but their ready availability for experiments will undoubtedly continue to be exploited. This volume does not by any means exhaust possibilities for experiments or for field studies. For example, comparisons of breeding densities and reproductive success in more extreme environments (hot desert, alpine, or boreal) have never, to my knowledge, been made; the only field studies reported here were in warm, humid areas, in connection with encephalitis transmission.

This presentation is clearly printed, well bound, and I detected only three minor proofreading errors.

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Fisheries of the North Pacific, History, Species, Gear and Processes

By Robert J. Browning. 1974. Alaska Northwest Publishing Company, Alaska. 408 pp. 66 plates. $24.95.

This book is like a huge magazine supplement to your weekend newspaper. It's all about the North American fisheries of the North Pacific, and gives a good journalistic account of the fisheries, a splendid review of the fishing vessels and fish gear, and useful descriptions of fish handling and preservation at sea and ashore, salting, smoking, and canning. All of this is done comprehensively (334 pages, plus four appendices that total 54 pages) with lots of black-and-white photographs and text line-drawings. The text is breezy, often windy, but never difficult to follow. The author has obviously gone to much trouble to get his facts straight, and except for a tendency to be overdramatic, has produced an excellent account for anyone interested in west coast fisheries. Certainly, the book will be very useful to anyone who wishes to get into the fish business and is not sure what it's all about.

The 16 color plates are of poor quality and do not do justice to the fish or the fishing activities, but there are a large number of black-and-white plates that have historical interest, or that have particular value for clearly illustrating kinds of fishing gear, vessels, canneries and so on. The book has been well produced, and is worth the list price.

The last section of the text is a 10-page political pitch entitled "Questions . . . . Without Answers?" The question is "What is the future for United States fisheries? and certainly the author does not have the answers. The decline of the fisheries is attributed to the effects of foreign fleets and the costs of marketing fish in the United States. The cure is for the government to provide help, and to manage United States fisheries as an entity (no more States rights) and to do all this in the best traditions of vigorous diplomacy. The United States government "must claim and exercise complete control over all fisheries along its coasts, beyond the Continental Shelf when necessary or beyond any mileage limit when necessary. This can be done by explicit and rigidly enforced international — even global — agreement." The author goes on to damn the Russians and Japanese for catching fish off North American coasts, then blasts Peru and Ecuador as "20th century pirates" because they enforce claims for 200 miles by seizing United States tuna boats. Red China is condemned on the grounds that, if they do fish far afield, they probably "cannot be brought to heel" and it is feared that as "mad dogs" they may set a bad example for other countries.

This unfortunate and partisan excursion into international fisheries matters will not perhaps offend the audiences of Alaskan fishermen, to whom it is primarily addressed, but from a Canadian point of view it mars what is otherwise a handsome compendium of information on west coast fishing.

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New Systematic Data for the North American Caddisfly Genera *Lepania, Goeracea,* and *Goerita* (Trichoptera: Limnephilidae)

By Glenn B. Wiggins. 1973. Life Sciences Contribution Number 91 of the Royal Ontario Museum, Toronto. 33 pp. $2.50.

Most of us, or at least those of us who have spent much time peering into ponds and streams, are familiar with the small conical cases constructed of sand grains or pieces of plant material that can be seen crawling about in bodies of water. If not, then we are all surely familiar with the small moth-like insects — the adult caddisflies — that are often attracted to lights in numbers on warm summer evenings. In North America there are over 900 species of caddisflies, representing 17 families. This publication covers three genera of one of the larger families, the Limnephilidae or northern caddisflies. Three of the five species discussed occur along the Pacific coast and the other two in the eastern and southeastern United States.

Descriptions of the genera and identification keys to the species are included in the booklet, which is illustrated with 34 figures consisting of drawings of excellent quality.

The purpose of this publication is as suggested in the title, to present new systematic data for the three genera mentioned, and therefore it will be of interest primarily to caddisfly specialists and to aquatic biologists working in those areas mentioned above.

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At Home With the High Ones

By John S. Crawford. 1974. Alaska Northwest Publishing Co., Anchorage, Alaska. 32 pp. 32 photographs. $9.95.

The prominent feature of John Crawford's *At Home with the High Ones* is the publication's unique duality. This duality runs through all three major aspects of the publication—format, style, and content.

From a format standpoint, the author/photographer himself acknowledges the duality of the publication by referring to it as a "portfolio of photographs and text." Compared with the standard format of pictorial essays, which is pictures interspaced with words, Crawford here presents two distinctly separate packages: a package of eight-by-eleven-inch photographs and a small soft-covered booklet. Although the pictures greatly add to the booklet's reading pleasure, they are not a necessity for enjoyment of the booklet.

The duality of Crawford's writing is that he uses a journalistic style, lacking in scientific rigor, yet he presents information in a detailed and well organized fashion. Typical of this style are his comments after having observed a bighorn ram duel. "In an instant following the rams' impact, a shock wave ripples down the muscular back of each antagonist, and their hind hoofs leave the ground, driving out straight and stiff behind them."

The author best states the intent of his publication. "This book relates some of my experiences in studying the Rocky Mountain goat, the bighorn and Dall sheep and other wildlife linked in their mountain ecology." It is only after reading part way through the booklet that the reader becomes aware of the book's duality in content. The reader cannot help but feel that the author is interested in mountain ungulates because they are a part of the mountains which fascinate him. "Both predator and prey species are magnificent animals, thrilling to see in their habitat, and both are invaluable aesthetic assets to the north country scene."

The theories and ideas presented in the text are often of the 'common gossip sort' rather than being substantiated scientific findings. For instance, consider the following statement. "Among outdoorsmen there has been much argument concerning the rarity of Rocky Mountain goat and mountain sheep mingling where they share the same range." Having presented the argumentative idea, the author then freely expresses his own ideas based upon his first-hand observations.

The publication's big bonus is the collection of photographs. While the average reader will read the text within an hour, the photographs are suitable for framing and make attractive wall hangings for den, office, or study.

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Butterflies of the World

By H. L. Lewis. 1973. Harrap, London. 208 colored plates, 312 pages. Canadian Distributor: Clarke, Irwin, Toronto, Ontario. $37. (Can.).

It is a great pleasure to review this handsome and useful book. It closes a long-felt gap, for the professional as well as for the average collector, for somebody who limits his interests to what is nearest to him as well as for the worldwide worker. Both will find what they were looking for and more than that; and this in one easily handled volume. Lewis' publication does not claim to replace the many volumes of Seitz or any of the field guides dealing with different countries and regions; it simply summarizes the world's butterfly fauna in its own original way and makes possible a fast look and a fast determination without a great amount of time spent. It accomplishes this not so much with elaborate text and many keys but with unbelievably realistic colored photographs of specimens in the collection of the British Museum (Natural History), which make the book still more valuable as a documentation of one of the world's largest and most famous Lepidoptera collections.

The material is arranged by faunal regions with the large and unwieldy palaearctic region split into Europe and Asia. On the plates species are arranged, as far as possible, in alphabetical order making the appropriate illustration easy to locate. In the text are given the country and locality where the species is most frequently seen; the food-plant of the larvae in many cases; any dependence on ants, if known; and vernacular names in some cases. All this is explained in an introduction that deserves careful reading.

In the introduction the author explains the nomenclature used, although this topic necessarily meets with some difficulties when on a world-wide basis. It may be said that the author (a few cases, where I would have done otherwise, notwithstanding) did a good job in avoiding the problems. But he should in any case have mentioned the source for his names, e.g., Higgins and Riley for Britain and Europe, and, as far as I see,

Forbes for North America, and so on. There should have been a literature list where the interested user of the book could have sought more and detailed information. Such aid is absolutely necessary for anyone trying to arrange a collection with the help of the book, as a grouping to families alone is not enough. On the other hand, arrangement of the genera in a systematic order would have made illustrations of particular species more difficult to find and restricted the scope of the work. This literature list is one of the *desiderata* for the next edition of the book, doubtlessly to appear shortly.

Another valuable improvement would be a cross indexing of the text, so that at the end of one faunal region the species occurring there but figured in another region would be listed with an indication of where the figure is to be found: e.g., many North American species also occurring in Scandinavia (*Boloria* especially), or those common to Asia and Indo-Australia (e.g., *Vanessa canace*) to name only two cases, but there are many, many more.

It was, of course, not possible to check on every name and record in the book. Nevertheless we would like to draw attention to the following for emendation in future editions: Plate 18, one would like to see the most common American *Erebia discoidalis*; Plate 14, Number 24 is a *Vanessa*; Plate 18, Number 15 is *Enodia* and not *Gnodia*; Plate 19, Numbers 6 and 7 have to be exchanged one against another; Plate 19, Number 11 is a *Celastrina* not "*Cyaniris*" (see Plate 9 Number 13); Plate 15, Number 3 is not American but Indo-Australian (like all Pacific Islands); other than North American: Plate 6, Number 2 *iphioides*; Plate 7, Number 5 *lupina*; Plate 11, Number 9, *lysimon* is invalid homonym to *knysna* (Plate 11, Number 8); Plate 33, Number 13 and Plate 35, Number 12 are identical species with different generic names (!); Plate 92, the heading Nympalidae is missing; Plate 125, Number 8 has to be *Lycaena abotii*; Plate 128, Numbers 57–65 has to be *Coeliades*, not *Coliades*.

Also in the text are discrepancies which should be amended, e.g., p. 220, Plate 22, Number 25: *Pholisora mejicana* (not *mejicanus*) is to my knowledge not flying in Canada: this is *Pholisora catullus* which should at least have been named as "similar."

Nevertheless, it was a pleasure to review this book and we wish it all and every success; however, we suggest that in future editions the determinations of the species, their names and their spelling as well as the text in general should be thoroughly rechecked.

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BOTANY

Mushrooms of North America

By O. K. Miller, Jr. Second printing, May 1973. Dutton and Co., New York. 360 pp. $20.75. Available in Canada from Clarke, Irwin and Co., Toronto.

There are a number of books which deal with recognition of the commonly occurring mushrooms; however, Dr. Miller feels that his will "satisfy the needs of all types of possible users: the casual observer, the ardent amateur mycologist, and the student of biology." The geographic area covered is the continental United States and Canada.

In appearance this book is pleasing. The cover is a warm, coarsely woven linen embossed with a picture of morels. The quality of binding appears to be very good, the print is large and easily readable, and the printing is of a high quality. The 292 colored photographs, large enough to be both technically useful and aesthetically pleasing, are one of the better published collections of fungus illustrations. The book, 18.5 cm wide and 26 cm high, contains 360 pages, which include 108 pages of plates in color and nine pages of black-and-white drawings.

The first printing of this book was reviewed by Dr. K. A. Harrison, Kentville, Nova Scotia in the journal *Mycologia* (Vol. 65: 977, 1973). The second printing has some minor changes, apparently based on Harrison's review; for example, the correct spellings for *Hericium*, *Morchella semilibera*, *caesarea*, etc., have been inserted, the fungus numbered 152 is now labelled *Mycena elegantula*, and the order of a few of the plates has been changed with no adverse effects.

Miller presents and enlarges upon the better features of several earlier books on mushrooms. The amateur will find these features easy to use and generally helpful, particularly the plates, the section describing the use of keys, the illustrated keys, the illustrated glossary, and the highlighting of key characters of each mushroom in boldface.

The major drawback in the book is the great number of errors, and anyone not familiar with the mycological literature and mushrooms should be careful when quoting it. These errors appear in several forms: misspellings, incorrrect author citations, mistakes in

the bibliography, imprecise wording, incorrect punctuation, lack of italics for some generic and specific names, wrong verb tenses, etc. Following are a very few comments on particular items, starting with the title, which seems rather immodest, when one considers that there may be as many as 10,000 species of gilled mushrooms in North America. In the Contents, the Gasteromycetes and Heterobasidiomycetes are given the same rank as Basidiomycetes, even though they are themselves Basidiomycetes. The simplified Picture Key presents each of the principal groups in the form of several ink drawings of representative species. The drawings of Boletes, Polypores, the Bird's Nest fungus, and the Jelly Fungi are too small to be helpful to the inexperienced. In the paragraphs on Collecting Methods it is mentioned that the taste of the mushroom should be recorded; however, the method of tasting is not mentioned. To taste an unknown, possibly poisonous, mushroom, place a small piece (*ca*. 5 mm square) on the tip of the tongue, crushed repeatedly by biting, then spit the pieces out; *never* swallow them. The paragraph on the names of authors that follows the species' name contains a number of errors. For example: species number 18, the authors should read "(Fr.) Mass."; 21 should read "(Fr.) S.F. Gray"; and 264 should read "(Underwood) Murr." Furthermore, the List of Abbreviated Names of Authors of Fungi (p. 359) contains notable errors and omissions. Some are: Atkinson's initials are G.F.; Berkeley's are M.J.; some correct spellings are Czerniaiev, Kalchbrenner, and Klotzsch; a confusing omission is the name of Wm. Curtis, which Miller abbreviates "Curt.," the identical form used for M.A. Curtis; throughout the book the names Léveillé, Pilát, Quélet, Mérat, and Müller lack the accents; some of the abbreviations in the text but not in the List are 194 Sing., 245 Paul., 285 Kl., 329 Walf. [sic], 369 Desv., and 392 Raitv.; finally "Vahl." is a rather unusual abbreviation for Vahl. Mycologists will not be misled or confused by some of these perhaps minor points but in a book designed for students, general biologists, and naturalists these mistakes could be very disconcerting.

Throughout, the word "stalk" is used whereas "stipe" is usually heard. The use of "veil" instead of "annulus" or "ring," for a part of the partial veil is uncommon and misleading not only because it is rarely heard but the glosssary definition of veil refers only to the universal veil. Also in the glossary see the unique definition of "clamp connection," and compare the definition of "Melzer's reagent" with "dextrinoid." "Chicken of the Woods" is the common name usually given to *Polyporus sulphureus* but Miller applies it to 237 *Rozites caperata*. And *Rhizina* is misspelled in every instance noted.

In summary, the Canadian interested in mushrooms should initially consider two books, which are complementary: Lange and Hora, *Mushrooms and Toadstools*, Dutton, New York, 1963, *ca*. $7.00; and J.W. Groves, *Edible and Poisonous Mushrooms of Canada*, Department of Agriculture Publication 1112, 1962, *ca*. $10.00. The excellent photographs in *Mushrooms of North America* nicely complement these texts. Although most of the species in Miller occur in Canada this is not always noted and except for a few personal experiences of the author there is little reference to Canada's flora. And the authoritative book on Canadian mushrooms by Groves is not cited.

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A Flora of Southern Illinois

By Robert H. Mohlenbrock and John Voigt. 1974. Southern Illinois University Press, Carbondale and Edwardsville. 390 pp., 77 plates. $3.95 (US).

This appears to be an exact offset reproduction on a thicker and softer paper of the 1959 hardcover glossy-paper edition which at the time sold for $7.50. The print is clear and legible, but the illustrations have suffered slightly in the reproduction, being somewhat darker in tone.

The book contains a short introduction, keys to families, genera and species, and easily flowing more or less short paragraphs which present the ecology and distribution, frequency, occasionally a few descriptive words, time of flowering, and usually a very cryptic specimen citation. References are given to illustrations in *The New Britton and Brown Illustrated Flora*.

That this *Flora of Southern Illinois* has been well accepted is borne out by the necessity for printing this second edition. A reviewer of the first edition (American Midland Naturalist 64: 235–254, 1960) suggested that in future editions the addition of a map, and the realignment of the genera and species, either alphabetically or numbered in the order of the key so that the text might be more readily consulted, would greatly enhance the work. It is unfortunate that this was not done.

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The Plantains of Canada

By I. John Bassett. 1973. Canada Department of Agriculture, Research Branch, Monograph 7. 47 pp. Free on request from Information Division, Canada Department of Agriculture, Ottawa K1A 0C7.

This monograph is a revision of the taxonomy of the Plantaginaceae in Canada. Mr. Bassett has studied the taxonomic relationships within the plantain family in North America for several years and it is satisfying that he has undertaken to remove some of the conflict that has arisen from excessive synonymy.

A concise key to the Canadian genera and species is provided to distinguish the 10 native and 7 introduced species of *Plantago* and *Littorella americana*. The synonyms are listed at the end of the text for those familiar with earlier names. For each species, the source of the type specimen, the synonyms, and the common names are noted. It might have been useful to denote the recommended common name for each species as recognized by the Canada Weed Committee so that less confusion would result from the continued use of common names.

Each plantain is well illustrated with drawings of a flowering plant, capsule, and seed, plus a distribution map. But it is unfortunate that the same vegetative profile (leaves, caudex, and roots) was used in two cases, with the appropriate spikes inserted. It may have been warranted with the two subspecies of *Plantago elongata*, presumably to emphasize that they are morphologically similar. There is less merit in having done the same thing with *P. major and P. rugelii*. Lamina of *P. rugelii* are usually oriented in a vertical position and the roots are comparatively thicker with few subdivisions. The descriptive data are quite complete with additional notes on pollen morphology, chromosome number, and general biology.

The author has shown the geographical range over North America for some species and just the Canadian distribution for others. Supplementary information on North American distribution would have been useful for all species. Perhaps a map of Canada upon which are represented the boundary limits of Canadian plantains might have been useful to the casual observer, especially as an aid to determine which species one could expect to find in different parts of the country.

This booklet is indeed a very useful publication. Recent taxonomic corrections in the Plantaginaceae are reported, which should aid the field biologist involved in the analysis of herbaceous vegetation. The technical description is useful to the specialist, yet the visual display not only sets a standard worthy of subsequent reports of a similar nature, it has increased its appeal to those who might forego the pleasure of ''discovering'' the inconspicuous members of the ground flora.

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The Genus *Salix* in Alaska and the Yukon

By George W. Argus. 1973. Publications in Botany Number 2, National Museum of Natural Sciences, Ottawa. 279 pp. $7.50.

This book is a detailed monographic treatment of the willows (genus *Salix*) in Alaska and the Yukon by a recognized authority on the group. The genus *Salix* in this area, as well as across Canada, is one of the largest, most widespread, and most taxonomically complex genera, and is also of considerable ecological and evolutionary interest. Thus this monograph is most welcome in providing a workable taxonomic treatment of the group and contributing to a better understanding of each included taxon. The treatment is based on extensive field studies plus the analysis of numerous herbarium specimens from 22 North American herbaria. That the study could have had an even larger specimen base is pointed out by Hultén (1973. Botaniska Notiser 126: 459–512), who deplores the fact that his own large Alaskan and Yukon collection at Riksmuseum in Stockholm (S) was not consulted.

The heart of the book is the key to the 41 species recognized for the area, followed by detailed descriptions of each species with regional distribution maps and photographs. The key to species appears well constructed and practical to use, except that the inclusion of the number of nectaries in the early leads of the key will pose some difficulty for amateurs of the group. Included with the species' descriptions are indications of habitat and range, followed often by a discussion of taxonomic relationships and variation within the species. Comparison tables are frequently included, which compare and contrast similar species, subspecies, or varieties, and graphs are sometimes inserted to show infraspecific variation.

Preceding the taxonomic treatment itself is a discussion of general problems in the genus, including taxonomic relationships, hybridization, polyploidy, and ecology. Subdivision of the genus into meaningful sections is considered a difficult problem by the author, who recognizes 16 sections of *Salix* in Alaska and Yukon. A point of some controversy concerns the amount of occurrence and evolutionary importance of natural hybridization among *Salix* species. It is clear that various authorities, including Hultén (1968. Flora

of Alaska and neighboring territories), recognize far more willow hybrids than does Dr. Argus. These authorities have often considered interspecific hybridization as one of the main causes of problems in *Salix* taxonomy. Dr. Argus, however, definitely plays down the number of natural hybrids and the role of hybridization in *Salix* evolution as is indicated by the following statement: "In my field experience natural hybridization was encountered infrequently, supporting the view that hybridization and introgression, although present in *Salix*, are not the major causes of variability" (pp. 8–9). It is difficult for a non-expert in the group to know whose interpretation regarding hybridization in *Salix* is the more correct.

The author points out that the species of the genus *Salix* form a polyploid series and that in some cases chromosome numbers vary within a single species. He includes a table of chromosome numbers for 33 taxa indigenous to Alaska and the Yukon, although many of the reports are based on counts from elsewhere. Another valuable aspect of the monograph is the discussion of the ecology of willow species in the study region. Although *Salix* species occupy a wide variety of habitats, all of these are subject to change, either because of physical disturbances or because they represent early successional stages. Of interest is the included ecogeographical key which sorts out the *Salix* species of Alaska and the Yukon according to their geographical regions and habitats.

A worthwhile feature of this monograph which deserves mention is the complete citation in the appendix of all voucher specimens seen by the author. Here the list of specimens is given in the form of a computer print-out of data which had been key-punched on IBM-type summary data cards and machine-sorted in terms of taxa and geography. The author considers that the use of computerized data storage and retrieval methods to prepare such a list of specimen citations represents an innovation which permits the complete documentation of research materials at a modest cost. In reality, it would seem that the main problem in providing complete specimen citations in monographic works is the finding of a publication medium willing to provide space for such an extensive list.

The format of the book is made convenient for the reader by the placement of the range maps and illustrations adjacent to the species descriptions. The book is well produced with readable type on attractive paper. This is a well-edited book with only a few spelling errors noted. The book is recommended to both scholars and amateur botanists as a valuable addition to the study of the flora of Alaska and the Yukon as well as of adjacent regions.

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Atlas Florae Europeae. Distribution of Vascular Plants in Europe

Edited by J. Jalas and J. Suominen. 1. Pteridophyta (Psilotaceae to Azollaceae) 3 + 150 maps + folded base map. 1972. 121 pp. $10.00 (U.S.); 2. Gymnospermae (Pinaceae to Ephedraceae) 50 maps. 1973. 40 pp. $4.00 (U.S.). The Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo. Distributed by the Academic Bookstore, Keskuskatu 1, SF-00 100 Helsinki 10, Finland.

The mapping of the distributions of all the native and introduced vascular plants found in Europe is a monumental task. This task, however, is one which has been undertaken by a team of regional collaborators from 28 countries, headed by a Chairman (J. Jalas) and Secretary General (J. Suominen) with several advisers and consultants on taxonomy and nomenclature.

Atlas Florae Europaeae generally parallels *Flora Europaea*. Where differences occur, these are duly noted under headings of Taxonomy, Nomenclature, and Notes which accompany each distribution map. Through the comments, synonymy, and references which are presented, students will have a key beyond what is given in *Flora Europaea*, to many of the problems which remain to be solved in the study of the flora of Europe. References are given too, to other published maps.

For purposes of mapping, the continent of Europe has been divided into 4400 squares based on the 50-km square of the UTM grid maps of the scale 1:1,000,000. The base map shows shorelines, major rivers and lakes, with the Azores and Spitzbergen as insets. Various symbols are used on the maps to indicate native occurrence, introduction, questionable status, extinct, probably extinct, uncertain records, and even the age of records for introduced species, all of which make the maps most useful and valuable. The maps will serve not only to show where the various plants are known to occur, but will serve as a stimulus to the initiation of botanical surveys in areas which are relatively unknown.

Two fascicles are now published and three others which will extend the treatment to the Caryophyllaceae are expected to be completed and published by 1976. This will then cover approximately half of Volume 1 of *Flora Europaea*. At this rate it will probably be 1980 before even the species treated in this volume have been mapped. One wonders if the editors and their

team of supporters across the continent will not lose their impetus, and the project grind to a halt. Three volumes of *Flora Europaea* have already been published (1964, 1968, 1972) and the remaining two on this basis will be out in 1976 and 1980. At the rate the maps are being completed and published it will be at least 15 years before the mapping has caught up to where the flora is now, and a further 12 years to the completion of the project. I wish the editors every success, because this is a most important work both for the amateur and professional botanist, but to ensure completion I believe that every means possible should be taken to speed up the operation.

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Mosses of the Great Lakes Forest

By Howard Crum. Contributions from the University of Michigan Herbarium. Volume 10. 1973. Ann Arbor, Michigan. 404 pp. Paperback $6.00 U.S., plus $.50 postage.

For the person looking for a good book to identify mosses from southern Ontario and Quebec, Howard Crum has produced a winner with *Mosses of the Great Lakes Forest*. The book is actually intended for his bryology students at the "Bug Camp," which is the popular name for the University of Michigan Biological Station (UMBS) on the shore of Douglas Lake, located in the northern part of Michigan's Lower Peninsula. But it will work equally well for anyone wanting to learn the mosses in the Great Lakes – St. Lawrence Forest region.

The flora and fauna of the Douglas Lake region are probably better known than for any other part of North America. The UMBS has been operating for 65 years during which period over 6,000 students have tramped over the vegetation to study the numerous plants and animals present in the area. Besides Dr. Crum, there have been several other notable bryologists who have taught at the Station, namely George E. Nichols, William C. Steere, Margaret H. Fulford, Paul M. Patterson, and Aaron J. Sharp. Many others have studied there for brief periods during the summer.

The book contains a 14-page key to the genera of Michigan mosses, a key to the genera and species of mosses, including *Sphagnum*, found in the Douglas Lake region, and the text gives incidental means of identifying all of Michigan's mosses. The brief and simple keys often present a mixture of gametophytic and sporophytic characters. Since macroscopic and microscopic characters are used, both a stereo and a compound microscope will be necessary to identify the mosses.

There are descriptions of families, of genera, and of each species in the Douglas Lake region. Following these are a list of reported chromosome numbers, references to illustrations, habitat and substrate information, general distribution, distribution in the Douglas Lake region, and sometimes a discussion regarding taxonomic problems. At the back of the book is a 13-page glossary which is not illustrated and an extensive 20-page bibliography. A short subject index concludes the book.

One of the best features is the 1004 illustrations which are interspersed throughout the book. They are mostly drawn by Dr. Crum who carefully selected and illustrated the salient points and has done an excellent job of demonstrating the differences between taxa. Nearly all the Michigan mosses are illustrated and there are numerous habit sketches so that one may get a "feeling" for some of the genera on the basis of the habit sketches alone. Unfortunately, the magnification is not indicated for any of the drawings. Sometimes the size of the illustrated feature is not mentioned in the description so that comparison is difficult when one can only assume that similar structures of different taxa are drawn at the same size.

Another attractive feature of the book is the bits of moss lore that are interspersed from cover to cover. Therefore the book will be of interest to others besides those merely wishing to learn the names of mosses. Included are items such as uses (including decorating, nesting material, gardens, etc.), food value, spore production, peristomes, phototropism, luminescence, moss balls, dispersal mechanisms, regeneration, reproduction, succession, and evolution. Students should find this information helpful in introducing them to the entire field of bryology; for those not wishing to specialize in bryology it should at least add some facts to help play the game *Trivia*.

I only wish that a good book such as *Mosses of the Great Lakes Forest* had been available when I was a student learning the mosses, but even as a professional bryologist, I have learned many things. Dr. Crum has done an excellent job of presenting the information necessary to identify the mosses, as well as maintaining one's interest in bryology. The book is very reasonably priced, especially when compared with other books printed today. I can recommend it to anyone with the desire to learn the mosses of the Great Lakes – St. Lawrence Forest region.

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ENVIRONMENT

Cities and Geology

By Robert F. Legget, with foreword by Professor Quido Zaruba. 1973. McGraw-Hill, New York. 624 pp. $15.50.

In 1970, the net increase of the world's population was approximately 138 people per minute. Between 1750 and 1900, a span of 165 years, the population doubled from 700 million to 1,600 million, and if this rate of increase is maintained, will again double before the end of this century. These figures are well known to all who appreciate that the earth's resources will soon be stretched to their limit. But the impact that this increase in overall population will have on our urban populations, as a consequence of the even greater rate of increase in the ratio of urban to rural populations, is appreciated only by planners and demographers. More than 50 percent of this inevitably large population will live in cities compared to the present 20 to 25 percent. Thus before the end of this century, approximately 7.4 percent of the United States will be paved over or built upon to accommodate people. This is more than twice the area now so occupied and is equivalent to the total area of England, Wales, Scotland, and Czechoslovakia combined. This trend towards increasing urbanization of an expanding population is not confined to western countries; in the sixties, the number of towns in the tropics with populations of a million or more increased from four to fourteen. It is clear that city planning will become increasingly important, and Robert Legget is concerned that due consideration be given to the geology of urban areas in order to ensure proper land use.

Chapter 2 describes the influence of geology on the location and development of many ancient cities and how man's actions have interfered with nature, in some cases with disastrous results. The position of the geological sciences in urban planning is discussed in Chapter 3. The role of the geologist and his contribution to urban development has probably been neglected or only partially acknowledged in the past. Robert Legget demonstrates that geology is a necessary factor in more than half of the disciplines involved in planning. The elements of the science are described for the benefit of non-geologists, and examples are presented of how geological data may be collected and presented for planning use.

The next five chapters are an amplification of Chapter 3, and deal in depth with various aspects of urban geology. Chapter 5 is concerned with the hydrogeology of cities. The principles of climate, surface and groundwater are discussed, followed by a description of the water supply systems of some larger cities, and further sections on salt-water intrusion, groundwater recharge, waste disposal, drainage and floods. The foundations of cities are described in Chapter 5. The consideration of general aspects of foundation design, soil mechanics, and subsurface exploration is followed by examples that illustrate the problems of building on various geological materials. Excavations beneath the cities, dealt with in Chapter 6, is a fascinating account of the various ways in which men have used tunnels and underground excavations for shelter, access, mining, and transmission of services. The construction materials of cities are examined in Chapter 7. The use of stone, brick, soil, concrete, sand, and gravel are each discussed at length. The geological aspects of the disposal of rubble, domestic and industrial wastes is considered, and finally there is a brief section on natural resources such as water, oil and gas, and coal, that may be found beneath cities.

Legget attaches great importance to the problem of the development of land geologically unsuitable for urban use, and it is probably for this reason that Chapter 8, "Geological hazards and cities," is the longest chapter. Hazards such as earthquakes, tsunamis, floods, subsidence, landslides are illustrated with many examples, and their general relation to geology is well explained.

"What every city should do" is the topic of the final chapter. Municipalities must ensure that surface and subsurface data are collected and stored in a system from which they may be readily retrieved. Ways and means of achieving this are discussed, and examples are given of cities that are moving towards this ideal.

The bibliography is a most valuable contribution. It consists of more than 400 titles arranged by chapter and is followed by three pages of suggested readings with annotations, again arranged by chapter. The indices are conveniently subdivided into name index, place index, and subject index. The more than 200 illustrations are clear, well chosen, and conveniently placed in the text. The flowing style of the prose and the clear presentation will be recognized by anyone who has heard Robert Legget lecture. The book is of such scope and depth of detail that experienced geologists, engineers, and planners will discover new information; and such is its clarity and organization of presentation that it will be appreciated by anyone who shares Legget's concern for the cities. Canadians will welcome the many examples from Canada's cities.

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Natural Environments: Studies in Theoretical and Applied Analysis

Edited by John Krutilla. 1972. Resources for the Future, Inc., Johns Hopkins University Press. 352 pp. $18.97.

''Natural Environments'' is perhaps a misleading title. Naturalists would automatically presume this book entirely concerns investigations of natural environments. Then when you learn that most of the authors are economists and the theme of the book is wilderness versus development, you think Oh great! — perhaps someone has finally worked out a good way to evaluate wilderness in economic terms that politicians and developers as well as naturalists or biologists can understand.

Don't be too enthusiastic. Some of the articles do suggest methods of evaluating wilderness, and some contain elaborate economic theory, but there is a subtle division between the two. In fact, the greater part of the book deals with economic evaluation of alternate uses of wilderness resources. The problem is in the word use. The economic value of a natural resource is considered in most cases to exist as recreational development. Although recreational development, especially if it is very low-keyed, is much preferred to extraction or destruction of wilderness resources, one cannot exactly call this an evaluation of the *natural* environment. Development and natural are contradictory terms.

My overall impression of the contents of this book was very good. Aside from the misleading title, the different articles in this book are clear in their premises and very definitely oriented towards recreational development analysis. Taken in this context, the book is an excellent reference. Articles are written by some of the top authorities in the field and cover the economics of alternate land uses, management of parklands, carrying capacity, trends in recreational land use, waterfowl management economics, as well as articles on numerical taxonomic classification of waters, and appraisal of landscape aesthetics.

In the introductory article, the editor, Krutilla, summarizes the other nine chapters of the book and gives his views of their contents. He also discusses the present condition of wilderness in the United States and projects future demands and problems. He strongly emphasizes the fact that industrial development irreversibly destroys wilderness. Thus it is imperative to assess all factors before irreversible decisions are made. Obviously, if in doubt, it is better to leave natural areas untouched as development eliminates future choice.

The next chapter, by Fisher et al., discusses the economics of alternate uses of natural resources. The benefit of undeveloped wilderness is generally considered in terms of *recreation*, i.e., what hunters, fishermen, and hikers or campers are willing to pay to use or protect the resource. Although not quite a naturalist's perspective, there are interesting environment-oriented thoughts. The irreversibility of development is also emphasized. Another interesting prospect, often not considered, is that as more of the land is developed the value of the preserved portion increases. With time, technological advances often give us alternatives to industrial uses of resources. Also, through the years the value of wilderness has increased much more quickly than the extractive value of the resources in it.

In the following chapter, Smith attempts to extend the model use by Fisher et al. which compares the extractive versus wilderness recreation value of a natural area. Smith's model allows for the prediction of population-induced and technology-induced changes in the resource-development relationship. As population increases, wilderness recreation becomes more valuable and non-extractive technology often replaces extractive resource use.

In the next three chapters, Stankey, Fisher and Krutilla, and Cicchetti all discuss the statistics of wilderness management and carrying capacity. Stankey feels that the United States Wilderness Act contains inherent contradictions between its goals of development and preservation. This causes many management problems but Stankey asserts that without good management and recreational ''development'' the American wilderness may disappear. He presents a questionnaire designed to assess what nature ''purists'' desire in a managed wilderness.

Fisher and Krutilla attempt to evaluate the optimal density for wilderness recreational use. The maximum value of the (use density) × (willingness to pay for low density) × (use demand) equation is depicted as the maximum benefit from a recreation area. Again this approach is one of an economist, not necessarily a naturalist.

Cicchetti analyzes the statistics of wilderness users, giving a large number of generalizations such as these: nature purists hiked more often as children, were older the first time they experienced wilderness, are more apt to have grown up in cities than small towns or rural areas, have higher education, more money and leisure time, are male, and belong to nature clubs.

Brown and Hammack present yet another economic appraisal of wilderness use. They evaluate the socio-economic relationship of migratory waterfowl. Ducks and geese are produced largely on prairie ponds and swamplands. But most of the hunter harvest and economic gains are elsewhere. Prairie farmers are draining an average of 1.9% of the wetlands per year. These authors are attempting to determine the total value of waterfowl hunting to the tourist-recreation

economy and through this a method to compensate farmers and reduce the drainage of wetlands.

The last three chapters more closely represent the naturalist's viewpoint. Sheldon discusses numerical taxonomy of small water-bodies. He feels this is necessary as a valuable aid and data storage method for wilderness managers. Also if one is to preserve unique parts of the environment, it is necessary to have some way to measure their uniqueness.

Litton and Craig finish the book with chapters on the analysis and appraisal of landscape aesthetic values. These are very interesting chapters for any naturalist to read. They present objective, scientific methods of evaluating components of the environment that we all value greatly but to which few, with the possible exception of artists or poets, can give adequate expression.

On the whole, this book provides a valuable reference for the library of any naturalist. Although at times the authors tend to get carried away with mathematical or economical analysis, they present novel ways of looking at the environment. As well, several of the chapters present valuable summaries of the ways that different authorities approach the problem of evaluating wilderness.

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Production, Pollution, Protection

By W. B. Yapp. 1972. Wykeham Publications (London), London and Winchester; Springer-Verlag, New York. 181 pp. $5.80.

Professor Yapp's book is a good example of an attempt to approach the problem of environmental pollution through a conventional biological framework. Although his analysis at times seems naïvely optimistic, it provides a valuable contribution to the environmental dialogue to balance some of the more alarmist statements of the past few years.

In the first section, "Production," Yapp makes a credible attempt to construct formulas by which we might measure quantitatively the output of a variety of bio-systems, including primary production in plant crops and secondary production in animals. The focus is the production of materials useful to man, but he also presents a sketch of the energy flow through the natural system, which would be of benefit to any environmentalist lacking a biology background.

In dealing with man's impact on the environment, Yapp mentions all the major types of physical pollution, but skirts, ill-advisedly I think, both the issues of long-term effects of pesticides and fertilizers on the soil, and the possibilities of dangerous combinations of synthetic substances occurring as man pumps more and more unnatural materials into the environment. Professor Yapp has chosen to ignore or is unaware of the message of *Silent Spring*.

Despite ending his book with a call to reduce both resource use and population growth, Yapp repeatedly falls into the trap of thinking that the economic mechanism controls the biological, and that some resources are limitless (Renewable yes; limitless no). He states that the economic difficulties encountered by industries that over-exploit their resources, as in whaling, provide sufficient protection for the species involved, and mentions Canada as a perennial source of cheap timber, discounting social and political changes that might occur here. We might conceivably take a chapter from the Arab's book and stop selling our resources at bargain basement prices.

In the final section, "Protection," Yapp raises some interesting questions. He challenges some of the conventional conservation myths by pointing out that the only 'natural' state in the environment is change, where animal populations, flora, and climatic conditions fluctuate continually within a balanced framework. Stopping forest fires or fencing off large areas is no more natural than growing wheat or building highways.

In an inference from this that admittedly ignores many of the more subtle psychological arguments of the wilderness advocates, Yapp proposes an enviro-ethic that would maximize the production of materials useful to man while least affecting the system stability. His assumptions are that man can beneficially influence nature through technology and that he cannot escape having considerable influence without ignoring that he is an animal with biological needs.

In addition to providing an articulate statement of the pro-technology perspective, the book is a gold mine of environmental trivia that will provide springboards for many interesting lines of speculation on environmental themes (for instance, the fact that the eggshell thicknesses of some species of birds which have been exposed to DDT, in the same manner as the eagle, are increasing). At any rate, the sacred cows of environmentalists need some challenging if the dialogue is to remain healthy, and although I remain unconvinced by Yapp's arguments the book made for stimulating reading.

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Natural Resource Policy in Canada: Issues and Perspectives

By Thomas L. Burton. 1972. McClelland and Stewart, Toronto. 174 pp. $3.50.

Can wise natural resource manangement and economic growth be reconciled? Are we moving into a post-industrial era? Can we plot a course between nationalism and international resource give-away? Is the answer to our problems "functional socialism"? Can we evolve an environmental conscience in time? These questions create much of the intrigue of Burton's book. It is long overdue. It is succinct. It provides a historical perspective for present predicaments such as federal versus provincial rights in the field of resources, and the lack of sufficient controls to protect the environment. In the last two chapters the author expresses his own viewpoint on where natural resource policy must go from here.

For the interested but non-professional person, the book draws together a good many facts: jurisdictional background for resource management in Canada and its changes over the years; the tribulations of resource management at the international level with case histories about marine fishing rights, and oil and gas management; the gradual evolution of the concept of conservation; the philosophy of Canada's three major federal parties concerning nationalization of resources and environmental quality.

For the professional resource manager, Burton's analyses of these facts unearths additional intellectual pay-dirt, such as a well-documented belief that failure to assess "externalities" is a fundamental flaw of most present economic cost-benefit analyses. The effect of a proposed development on the environment is one externality that is usually overlooked. Another is the impact of a development on total supply of a given resource.

The failure of present economic planning to grapple with such things leads Burton to a belief that "functional socialism" may be a short-term solution. This is merely greater government control over externalities. Regardless of who owns the resource, private or public, only government has the ability to impose regulations that can take into account these all-important externalities. But that is only a short-term solution. In the long run, Burton points out that there is no substitute for "a drastic change in society's perception of the environment," or in other words the development of an ecological conscience, broadly understood and applied.

There are some solacing thoughts in the book. One is that growth and over-exploitation of resources eventually regulate themselves. This idea is developed historically by tracing society through four successive stages: pre-industrial with a preoccupation with subsistence; industrial with a preoccupation with production; mass consumption with growth a foremost objective; and post-industrial with quality, harmony and balance the major goal. Burton believes that Canada is entering the last stage, as evidenced by recent legislation to protect the environment, such as the Arctic Waters Pollution Prevention Act, and the formation of various Departments of the Environment. He suggests that growth stops when people perceive that the bad outweighs the good.

But the little flicker of optimism that this thought generates is partly dashed by events since the book was published. There is evidence now that when times get a bit hard, concern over the quality of the environment decreases. The relaxation of air quality and automobile emission standards in response to the oil shortage is an example.

The book has a few important short-comings. Its historical perspective suffers from omitting the national park movement, which, in terms of a world perspective, may be Canada's major contribution to natural resource philosophy and policy. Canada ran close behind the United States in the development of this movement, and names like J. B. Harkin should have found a place in the book. Nowhere in the book is wildlife ever acknowledged as a resource. This weakens a number of points, such as the historical review. For example, the Migratory Bird Treaty is one of the earliest international resource management agreements, and one that has successfully survived a long test of time. Omitting wildlife further weakens the book by omitting that much of the present concern over quality, harmony and balance has come from wildlife studies which have documented the deteriorating health of ecosystems, the decline in raptors, the dangerous mercury levels in pheasants, the radionucleotides in caribou. Both these serious omissions would have come to light if the manuscript had received adequate review by other resource management professionals. They were undoubtedly flaws caused by the speed of production.

Nevertheless the book is important to read. One can only hope that it gains a wide circulation in this day of deteriorating environmental quality and resource depletion, for it grapples with some of the most critical problems of our time.

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The Pollution Guide

By Tiny Bennett and Wade Rowland. 1972. Clarke, Irwin and Co., Toronto and Vancouver. 139 pp. $2.95.

In this compact but highly informative book, Bennett and Rowland have provided a wide-ranging coverage of the current status of many aspects of pollution. They have surveyed pollution of air and water and land; pollution due to oil, sewage, garbage, pesticides, phosphates, and people—even the seldom mentioned subject of radioactivity. Their illustrations are worldwide, but many of their data are Canadian, important contributions to an American-dominated subject.

If one has never read much about pollution, this book will be an eye-opener, both to the extent and variety of the problem. The person who is knowledgeable on the subject, however, will find that only some of the Canadian content saves the largest part of this book from being a repeat of what has been written elsewhere. For those who have read elsewhere, the latter parts of this book are the most interesting, for here the authors delve into the subject, however, of what can be done about the problems.

The chapter "Pollution, Politics, and Economics" talks about general solutions, starting with the concept of space-ship earth. A strong case is made for the imposition of a fee system for polluting industries as against a system of fines for convicted pollutors. Mention is made of legal actions that individuals or groups could initiate.

"You and Pollution" gives a large sampling of things that an individual can do to help solve the pollution problem. The book does not advocate a give-up-everything-and-go-back-to-nature philosophy. It realizes that most of us live in cities and that it is probably best that we continue to do so. The authors advocate responsible action and involvement by the individual. They suggest using public transit or bicycles, but when one must use a car, they show how to use it sensibly: don't idle unnecessarily, use radial tires, buy for economics rather than style, forget trading every two years. Get involved in recycling, but don't buy over-packaged products. Use soap, not detergents. Put some kitchen scraps with the leaves in the compost pile; this cuts down garbage and saves buying fertilizer. Buy and live in an old house; this saves the material of the structure, the land it is on, and prevents yet another form of pollution called slums. Use a hand-operated lawn-mower and smell the freshly cut grass.

There are many more ideas given which the individual can use. Most of them are every-day common sense, but each person reading the book will pick up a few he hadn't thought of. The only thing missing from this book is a workable suggestion for seeing that every individual uses these concepts, and perhaps this is too much to ask from even so well-done a pollution guide.

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The Polar Worlds

By Richard Perry. 1972. Toplinger Publishing Co., New York. (Published simultaneously in Canada by Burns and MacEachern Ltd., Don Mills, Ontario.) Volume 2 of The Many Worlds of Wildlife Series. 316 pp. $8.95.

The inside front fly stated that this book " . . . draws a fascinating parallel between the physical environment of the Arctic and Antarctic regions, delineating the links between them." Having travelled in both polar areas myself, I was keen to read another's comments on polar comparisons.

The book is divided into two main parts. Part I is on the Antarctic, and Part II is on the Arctic. The first has such subsection headings as: The Nature of the Antarctic; Seals of the Antarctic; The Fount of Life; Astounding Antarctica; and others. The second has: The Nature of the Arctic; Arctic Whales and Seals; The Walrus Herds; and others. Two very small subsections, one entitled "Links" on p. 128, and the other "In Conclusion" on p. 283, are the only parts which are correlative and comparative for both the Arctic and Antarctic.

I was more than a little disappointed with the contents of this book. I was unable to find a theme or purpose. It seems to be merely a random assemblage of facts and quotes from diaries and books of some polar adventurers. Details on habits and habitats of the Arctic animals are better than those of the Antarctic, but this is perhaps a reflection of the literature sources available to Mr. Perry, as this book represents mainly a library exercise. I have the impression that the book was written as an assignment from an editor or publisher, as I "felt" no author involvement.

There are a number of words the author used that are either unusual usages or are outright errors. For example: for 'throve,' read 'thrived' (p. 52); for 'outwith,' read 'outside' (p.131); for northing,' read 'north flowing' (p. 131); for 'distil,' read 'extract,' (p. 140); for 'precipitating,' read 'dropping' (p. 156). A bird's glands extract freshwater from saltwater, but they do not distil saltwater in order to make freshwater.

There are several errors or misinterpretations of facts. For example on p. 43, he wrote about "partially bloodless" fish. Either an animal has blood, or it has not. He mentioned that the " . . . circulatory blood of the ice-fish . . . is colorless and semi-transparent . . .."Possibly these bloodless fish . . . ." Arctic hares (p. 243), as do all other lagomorphs, have six, not four, incisors, and the foot pad on a lemming's foot is perhaps 2.5 mm long, not 2.5 inches (p. 247). And it is usually warble flies, not mosquitoes and blackflies (p. 265), which "drive the caribou to distraction."

The printing is large and clear, and almost free of typographical errors (I found two). The stipple drawings are excellent – clear and accurate. The cover is blue buckram, and the binding, though there is a thin cloth layer present, is mostly paper and glue. In my copy, the pages are tearing away from the binding in two places.

As there is very little probing into polar adaptations of animals, or interesting, provoking interpretations of polar phenomena, I do not recommend the book.

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Disposal of Plastics Waste and Litter

By J. J. P. Staudinger. 1970. Monograph 35, Society of Chemical Industry, Chemical Society Publications Sales Office, Blackhorse Road, Letchworth, Herts., U. K. 100 pp.

This highly technical book is not too erudite for most laymen, but with its statistics as to what fraction of British municipal waste is plastic, what the fraction will be in 1984, etc. There is a danger of missing the forest for the trees. A more pertinent picture may be obtained from a specific situation.

About five years ago the Pathology Department of a large Canadian university which daily performed many routine tests for hospitals associated with the university, switched from glass Petri dishes to plastic dishes which were discarded after one use. The benefit was an end to dish-washing costs, fear of contamination, etc. But for every benefit there is a cost, and in this case the cost was a severe disposal problem. Plastic dishes used with the more virulent cultures could not simply be tossed into the trash. They could of course be autoclaved to kill the cultures, but the plastic melted into a large amorphous blob which the trash removal contractor refused to handle since it caused damage to his compacting machinery.

The Pathology Department had its own incinerator in the building which could incinerate the dishes and their cultures without autoclaving. But this incinerator was about to be closed owing to the high cost of bringing it up to air pollution control standards. (An interim measure to reduce smoke production was to stop collecting material to be incinerated in green plastic bags. When good old paper bags were substituted, smoke was virtually eliminated.) The Department had access to a modern incinerator designed for disposal of this type of material, but this incinerator was about 25 miles away. The used plastic Petri dishes could be placed in plastic bags and sealed in steel drums for the trip. But there was fear of release of cultures in a road accident or during handling at each end of the trip. The dishes could not be autoclaved before the trip because the blobs were very difficult to burn. Also, autoclaving, transport, and incineration were approaching the cost of dish-washing. Even with all these problems the Department stoutly maintained that there would "never" be a return to glass Petri dishes.

Whether or not one believes the "energy crisis" to be real, the fact is that plastics and other products based on petroleum are experiencing sharply rising prices and shortages. The Pathology Department must have its supply of dishes every day. If, on occasion, dishes are temporarily unavailable at any price, there may be a return to glass Petri dishes somewhat earlier than "never."

In general it may well be that the plastics waste and litter problem will control itself as price increases and shortages proliferate. This is just one of a number of pollution problems that may be solved for us by dwindling resources. There is always a bright side!

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Canada's Water: For Sale?

By Richard C. Bocking. 1972. James Lewis & Samuel, Toronto. 192 pp. $6.95.

There have been many great plans for the use of 'continental' water supplies. Most of the plans are American, most of the water is Canadian. Many among us have some initial responses to the idea of large water transfers. It is not difficult to find Canadians who have misgivings about the Columbia River Treaty.

Richard Bocking's book goes far beyond the first reaction stage. In a series of 10 chapters he examines seriously the following major matters:

(1) The U.S. need for Canadian water. Is it real?
(2) The growing pressures to make water transfers.
(3) The support or non-support for water transfers.
(4) The social and environmental costs of dams.
(5) The North American Water and Power Alliance.
(6) The economics of water development.
(7) The phenomena of dam building and dam promotion.
(8) Water management alternatives in Canada and the U.S.A.
(9) The policy or lack of policy behind water programs in Canada.
(10) Water development and the Canadian identity.

The depth of ideas and information in each chapter makes it difficult to more than touch on the issues in review. Nevertheless several major messages emerge in the book as a whole.

The need for Canadian water in the U.S. has been greatly overdrawn by some politicans and promoters. Water is misused in many large transfer schemes now in the U.S. The judgment and the motivation behind many water proposals is questioned in the book.

Massive damming operations in several places in the world are revealed as environmental disasters as long-term effects begin to unfold. Many of the social costs in the wake of such operations as the W.A.C. Bennett Dam, and the High Aswan Dam are great but were never considered before construction.

Bocking makes the case that Canada is moving, without any predetermined plan, toward a situation where it will be forced into huge water transfers. The great waterways running east and west have given Canada much of its identity. With water deals we face not only the loss of real control over a major resource but also the loss of a heritage and an identity.

Water export plans give silent approval to the untenable precept that growth must go on. The engineering approach to over-population is to reach out further for more resources; the problems are worsened. It is depressing to reflect upon the loss of a heritage, an identity, and a quality of life as a part of an exercise in sustaining a growth process that must inevitably end.

Mr. Bocking's book is well researched and well presented. Although it is disturbing it is valuable reading to every Canadian. It should be equally valuable to every American.

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OTHER BOOKS

Ecology

By Robert E. Ricklefs. 1973. Chiron Press, Newton, Massachusetts. 861 pp. Introductory price $9.00.

This book is the definitive broad treatment of the theory of ecology. It warrants widespread and long-continued use. I make this assessment realizing that this puts it in the class with Elton's classic *Animal Ecology* which was definitive for its era. In comparing these two works, however, differences reflect the fact that Elton's book filled an open field and contained original concepts, whereas Ricklef's volume summarizes the vastly greater quantity and insights that have been generated in recent years. Ricklefs follows the sound rule of publishing new research and concepts separately from a textbook, as evidenced by the long list of his references at the end of the book. This avoids the impression that there may be first record of new concepts buried within this text.

The 46 chapters are grouped in parts devoted to the following sequence of subject areas: natural selection and adaptation, the physical and biological environments in the ecology of organisms, ecological genetics and evolution, genetics of populations, ecology of populations, and finally ecology of communities. Within each part the relevant topics are discussed in some depth. For instance, under Physical Environment, the following are dealt with: requirements of life, aquatic and terrestrial environments, space, temporal variation, adaptation and distribution, regulation and homeostasis, perception, and sense of time. Under Biological Environment these are discussed: predator and prey relationships, competition, social environment, sexual environment, life history strategies, the social insects, and the integration of populations.

The extensiveness and richness of the material in the book can be judged in part from the quantities of figures (329), tables (97), glossary entries (301), and cited references (approximately 705). In addition there is a list of some 46 books in a reading list, 42 journals,

7 reprint collections, and 13 books on environmental issues.

The writing is informative, easy to read, and aided by frequent clear headings. The ideas are developed thoughtfully from basic evidence. The prose is clear and well written; it communicates effectively. The meaning is not obscured by any forest of highly technical terms, and the terms that are used are defined in the glossary. The available theories relating to diversity in a community, number of species in a community, and energy flow are all explored.

I would criticize the book in a way which may verge on quibbling. Ecology is one of the widest fields of human thought, and hence it needs structured summarizing. This book does have Parts, Chapters, and Headings. But similar-strength headings may be major principles or more often lesser sub-units or even questions. For instance, one heading is "When does succession stop?" The word 'climax' occurs in the subsequent text but there is no formal statement of, or definition of, climax association. The several types of climax are not defined, nor does climax appear as a major heading or principle; it should result from that question.

A notable omission from Ricklefs' book is the discussion and description of practical field methods for both plants and animals. Understandably in view of the size of the book, these are left for others or the instructor to supply and to discuss the advantages and disadvantages relevant to each field method.

The treatment is ideal for a student who intends to make his career in ecological biology. It also suits and challenges the good student in another stream who would appreciate a real insight into ecology. Equally then, this book would be enjoyed by a thoughtful person who wanted to relate environmental concerns to his scientific background.

In the epilogue Ricklefs makes a plea for more quantitative scientific investigation of natural communities, and subsequent fitting of models. He closes with the hope that the future development of ecology will be broad enough to accommodate man as a phenomenon of the natural world.

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Geographical Ecology. Patterns in the Distribution of Species

By Robert H. MacArthur. 1972. Harper and Row, New York. 270 pp. $12.95 (U.S.).

This is an interesting and thought-provoking book for anyone who has some knowledge of ecology or biogeography. The late Robert MacArthur has had a pronounced influence in biology, and is perhaps best known for his application of mathematics in the development of biological theory. In the present book, however, MacArthur has made a fairly successful attempt to express his ideas verbally, limiting much of the more complex mathematical formulae to various appendices.

The nine chapters in the book cover a wide range of topics, with a considerable variation in the quality and depth of coverage. Chapter one, entitled "Climates on a rotating earth," is a superficial but well-done description of global climatic patterns and the coriolis effect. While climate undoubtedly has a great influence on distribution patterns of organisms, chapter one is seldom referred to subsequently.

Chapter two deals with competition and predation in very general terms. It is a subject where multiple explanations for observed phenomena are possible and concrete examples therefore are scarce. MacArthur states that proof (mathematical in this case) is given in the appendix, which is larger than the chapter. If the non-mathematician is not discouraged by chapter two, he or she will find the next four chapters a delightful mix of interesting ideas and interpretive theory. Most of the examples and ideas involve a comparison between the way organisms (mostly birds) survive on the mainland vs. off-shore islands. Differences in species composition and numbers, survival and extinction rates, and feeding habits are all discussed and a number of theories that may explain the differences are proposed.

MacArthur does not attempt to cite a large number of examples nor to propose all possible explanations. Rather he cites a few well-documented cases and presents his ideas concerning them in a clear and lucid style. The reader does not have to be skilled in mathematics to understand and enjoy these chapters. They can best be described as stimulating. The last two chapters, dealing with continental patterns of species diversity, differences in temperate vs. tropical species, and the time element are rather mundane, possibly since fewer examples are given and there are fewer original ideas. I do not mean to imply that the concluding chapters are not of interest. The entire book is essentially MacArthur's effort to stimulate thought and encourage research in a fascinating area of biology. He has been highly successful in this endeavor and any person interested in geographical ecology will find the time taken to read this book a worthwhile investment.

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Scientific Knowledge and Its Social Problems

By Jerome R. Ravetz. 1971. Clarendon Press, Oxford. 449 pp. $12.50. (See also: *New Scientist*, Vol. 51, pp. 756-758, 726; *Nature*, Vol. 234, p. 567).

In a recent interview (*New Scientist*, Vol. 51, p. 756) Jerry Ravetz is quoted as saying that ". . .the issue of science versus technology is now passé. All science is connected to industrial society." In this book, Dr. Ravetz examines what it means for science to be connected to industrial society, and what the future of science can be under these circumstances.

Notwithstanding a rather critical attitude towards much of what passes for science these days, Ravetz feels that an increasing number of practical problems will have to be solved through scientific research. He warns that the sheer size of these programs leads to increased State control and that the progress of science will increasingly become a matter of politics. With respect to the general public, Ravetz points out that what most people appreciate in science is not what scientists do, but their techniques and their magic. The techniques result in a collection of devices that make life easier, while the perceived magic is simply a reflection of the universal ignorance of the laws of nature. The purpose of this book is therefore not only to demonstrate the changing nature of science to practicing scientists, but also to explain science to the general public.

At first glance, Ravetz seems to fail on both counts. Although the book is thorough, coherent, and well documented, this reviewer found it dense and without rhythm. Its central message that science is changing in a way that may be detrimental to society, disappears under too much historical detail. Yet, the message is important and Ravetz' book deserves attention and study.

The book is in five parts. Part one deals with the varieties of scientific experience and reaches the conclusion that further growth of science is by no means guaranteed, but that it cannot be imposed by politicians and administrators. What science needs, according to Ravetz, is a "new leadership" capable of adapting the best of its heritage to the task on hand.

The second part discusses the uncertainty of facts and the limitations of scientific knowledge. Ravetz shows that the results of science can only be accepted as genuine if the criteria of adequacy and value coincide with the world picture of the culture to which they are offered. Although parts of what seems a coherent body of knowledge can survive a cultural transfer, much scientific knowledge is restricted by its cultural context and will be rejected in another cultural environment. Another limitation to scientific knowledge is the contrast between knowledge (which is public and demonstrable), and understanding (which is private and tacit). Ravetz touches briefly on the question as to whether true understanding of important things can be achieved only through mastering a body of scientific knowledge, or perhaps also through intuitive wisdom, direct illumination or in other ways. John Ziman, in reviewing the same book for *Nature* (Vol. 234, p. 567) concludes that Ravetz gives sufficient reason to reject the narrow intellectual method of physics as the paradigm of science.

The third part of the book deals with the decline of three aspects of the sociology of science: the protection of property, the management of novelty, and the control of scientific quality. The author concludes that the entire social system of science is degrading. Property now includes formal reports of insignificant work and personal contacts with those who administer research funds. The prestige given to novelty weighs the scales in favor of brilliant young men at the expense of older men of wisdom, while the classical system of quality control through peer review and internal hierarchies is slowly breaking down. For all of these reasons, Ravetz feels that the future basis of excellence in science must be more refined than the current "professional ethic" and more related to humanitarian commitment.

In the fourth part of the book, Ravetz turns to the difficulties of immature sciences, and the dangers that arise if such sciences are applied to real problems. In outward appearance, the immature sciences resemble established physical technologies, but Ravetz feels that many of them constitute gigantic confidence games. He fears that many of the social sciences are particularly prone to this type of corruption.

The book concludes with a look at the future. Ravetz foresees two developments: "industrialized science" (or commercialized science), and "critical science." Tame, industrialized science will constitute the scientific establishment, while critical science will be its opponent. The style of critical science will be political, like the politics of the Enlightenment, where a small minority used enquiry, exposure, and reason to arouse public concern on matters of human welfare. Without being mystical about it, Ravetz has much the same message as Theodore Roszak in "Where the Wasteland Ends": scientists must reclaim their identity as organisms. In order to rejuvenate science as a useful and humane endeavor, Ravetz admonishes us to turn once more to the original Baconian principles of "the love of God's creation, the pity for the sufferings of man, and the striving for innocence, humility and charity."

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One Man's Wilderness

By Sam Keith. 1973. Alaska Northwest Publishing Company, Anchorage, Alaska. 116 pp. $8.20.

In spring of 1968, Richard Proenneke was flown into an isolated lake in southcentral Alaska. There he built — no, crafted with hand tools, a cabin from natural materials and settled in for sixteen months of essentially solitary wilderness living. He kept a journal of his experiences (including enviable encounters with various wildlife species) and of the inward reflections about "life style" which were inevitable for one living under such circumstances. Sam Keith, a friend, later put the book together from journal entries and some of Proenneke's photographs.

The book is a commendable effort, although the photographs vary in quality. Many depict aspects of Proenneke's day-by-day existence, e.g., a stack of sourdough hotcakes, the cabin at various stages of construction, and a thermometer registering 50° below zero. Most wildlife photos are mediocre, although there is a fine shot of a magnificent bull caribou. Finally, there are some superb panoramas of Alaskan wilderness which are responsible for the book's unusual (and somewhat clumsy) 9" high × 12" wide format. Errors are few, although naturalists may frown at reference to a "Northwestern Shrike" and may be uncomfortable with Proenneke's tendency to make animals subject to his own brand of morality. On one occasion wolves "lost a few points" with him for a deed for which, from his description, they may not even have been responsible. Mostly, though, his wildlife adventures are fun; how many of us have played tug-of-war with a wolverine?

The real meat of the book is the idea. What do we "need"? What can we do without? What is real and what is lasting? Proenneke is not a Thoreau or a Muir, but the thoughts nevertheless get through. Some are in a humorous vein through dialogues with the Bible-totin' pilot friend, while others grow with notches in the cabin logs or the sound of evening quiet. "Doing a thing to completion satisfies a man," he observes simply.

The book is popular beyond the publisher's best hopes, suggesting that this one man's reality is many men's dream. It is perhaps fortunate that most are vicarious adventurers like Keith rather than "doers" like Proenneke, otherwise (ironically) "one man's wilderness" would soon be no wilderness at all.

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The Last Refuge

By J. G. Nelson. 1973. Harvest House, Montreal. 230 pp. $7.50.

Anyone who watches the late evening weather reports on television knows that the Cypress Hills area is a refuge from the more severe winter temperatures just north of it. The temptation to think "why aren't we there?" is unavoidable. The author has enhanced our feelings about the attractions of the region in a short and readable account of the white man's penetration of, and growing familiarity with, this "Last Refuge." The problem which is posed by this awareness is that once the attractions become more widely known it is likely to become a crowded refuge. In a sense Cypress Hills is a microcosm of the discovery, uses and abuses of the earth and its resources. If the refuge had been left to only a few it might, perhaps, have retained its state as of 1700 or 1800 or 1900, but since this has not happened what is needed is an educational effort to insure that a thoughtful and appreciative attitude will prevail in its future usage.

The author, a professor of geography at the University of Western Ontario, is the president of the National and Provincial Parks Association. As a leading conservationist in Canada he is writing about a subject of growing concern to many others.

The first and larger section of the book deals with the coming of the trader and traveller to the area. Their line of travel lay along the Saskatchewan and Missouri Rivers. Evidence is presented "of life, attitudes, hunting methods, fires and other phenomena" that are then dealt with topically in the remaining chapters, which constitute the second section. Discussed there, are "men, animal life and aspects of the landscape of the Cypress Hills country." The area itself lies in the southwestern corner of Saskatchewan, the southeastern corner of Alberta, and the adjacent territory in north central Montana. Roughly speaking it is between the upper Missouri and the South Saskatchewan Rivers.

The account of European expansion draws attention to the role of the indigenous peoples, the Blackfoot and Cree Indians primarily. It was to trade with them that the European first penetrated into the surrounding territory. To tell this story the author has consulted the original journals. The list of names of Europeans who first made their way into the Cypress Hills is impressive. Professor Nelson's footnotes are a kind of roll call of these famous figures: Arthur Henday, Peter Fidler, Daniel Harmon, Matthew Cocking, Alexander Henry the Elder, David Thompson, Alexander Henry the Younger, Lewis and Clark, George Simpson,

Palliser, Hind, George McDougall, Father Lacombe, and so on.

There has been an acceleration in change over the last 100 years. As late as the 1870s the Indians were able to retain much of their way of life. They had successfully absorbed the changes brought by the Europeans and worked out a life-style based on horse and buffalo. The Europeans remained on the periphery of the territory for the most part. With the destruction of the buffalo and the influx of white settlers by the late 19th century however, more serious changes began to occur.

The author concludes his timely tract with what can stand as a warning. "In about ninety years [since ca. 1880] we have moved from abortive efforts to save the bison to the point where the very air of the Cypress Hills might be polluted . . . . What will the Hills be like in fifty years if we do not seriously look at present economic activities and living patterns, and plan for life as well as growth, goods and earnings."

The native peoples assert that there are values which they retain which can be instructive. In 1969 Andrew Ahenakew, a Saskatchewan Cree whose family has been in positions of leadership for at least a century, addressed a message to the Queen. A portion of it touched on the subject under consideration. "We are told by your White scientists that the pollution which has come from technological advance may result in the death of all living things in the next decade or two. Indian people respect and admire the technical progress of White men, but we cannot help but be frightened and saddened by the threat to all living things on the face of the earth. We regard all living things as our brothers. We believe there can be advancement without destruction. So far, your people have taken everything but our greatest gift — that one we wish to give most of all! That gift is a way to have people survive in this world, and have the natural world that God created also survive. In a world that is looking for survival, we can teach."

Did the newcomers overlook some important concept that was to be found among the first people in the Last Refuge?

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The Titanic Effect. Planning for the Unthinkable

By Kenneth E. F. Watt. 1974. Clarke, Irwin and Co., Toronto. $9.25.

'The magnitude of disasters decreases to the extent that people believe that they are possible, and plan to prevent them, or to minimize their effects.'

This is the 'Titanic effect.' There is a basic human tendency to ignore warnings about imminent enormous disasters. Such disasters are outside the range of past experience. We ignore them. But the Titanic *did* sink. And from this unfortunate vessel comes the name for the generalization, and the name of the book.

Readers familiar with Kenneth Watt's writings will be aware that he is an expert on computer analysis of biological and social systems. For example, in his 1968 book *Ecology and Resource Management* he brings to resource management the mathematical methods routine in most other areas of science and economic life. So, perhaps it was to be expected that this specialist in human ecology would recognize in the world's economic problems the same root causes that are leading to resource depletion and pollution. It is our refusal to plan effectively (especially in the use of our vital resources) that causes harm to the environment and our life quality and also adversely affects the economy.

Drawing his examples mainly from major American industry the author shows that faulty forecasting, spurred by reckless desire for growth, leads to market saturation, unemployment, inflation, and the depletion of resources. Watt argues that conventional economic wisdom is defective in several respects and that these defects can be remedied by incorporating into the conventional wisdom the point of view of two new sciences: ecology and systems analysis. The conventional wisdom fails to realize that everything is interrelated, that there are limits to growth, and so on. As the author puts it ". . . the present public position is desperately short-sighted." It is just not possible to deal with the energy crisis by continually trying to increase supply in order to meet the demand. Neither can it be assumed that technological innovations will always occur in the nick of time. The penalty for continuing to hold conventional wisdom will be more severe in the future than it has been in the past.

Watt is critical of government. Instead of acting to prevent a social system from getting out of control it tends to do the opposite. Because governments are highly sensitive to vested interests the policies followed encourage rapid depletion of the world's energy supplies. And Watt does not see this attitude changing. He suggests that only an informed public together with market mechanisms will effect any changes that occur. Various methods effecting change are outlined.

In an intriguing chapter entitled 'Scenarios of the Future' Watt indicates the options still available to us and discusses the four possible futures most likely to occur. As the old phrase says, things will get worse before they get better. But Watt is convinced they will (or could) get better ultimately. He suggests that a

decline in world population will begin about the year 2000, and will stabilize at about one billion by the year 2500.

This is an extremely well-documented book. It is well written and well organized and should be in the stocking of every politician and industralist next Christmas. Ecologists will find it useful for their reference shelf. At the back it has a "Games for Decision Makers" section. There are three appendices, one of which is a listing of citizen's action organizations in the United States. There is an index and a reading list for each chapter.

The following is from the chapter 'Scenarios of the Future': " . . . humanity may have just one chance to attain a very high level of civilization on this planet, and we are involved in that chance right now." "This type of thinking was irrelevant for previous civilizations, they simply lacked the power to cut rungs off the ladder behind them." "It is unlikely that there will be significantly large undisturbed or unaffected refuges from which a new civilization could emerge if the dominant present civilization makes a serious blunder."

Watt believes this. I believe it. If only more people would. It may not be too late to devise the plan necessary to avoid that blunder.

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The Milepost — All-the-North Travel Guide (Alaska–The Yukon – Northern British Columbia – Northwest Territories)

Alaska Northwest Publishing Co., Box 4-EEE, Anchorage, Alaska 99509. 26th annual edition. 1974. 656 pp. Separate map. $3.95 (U.S.) + $2.00 additional if airmail specified.

For many years *The Milepost* has served as the handy mile-by-mile guide to travellers of the Alaska Highway and the connecting roads in the Yukon and Alaska. This edition has been greatly expanded to include roads in northern British Columbia and the Northwest Territories as well. The book contains not only a wealth of information on "things" to be seen along the route, but interesting facts on the history of the country, locations of picnic and camping sites, gasoline stations, lodges and motels. Illustrations include maps and scenic shots, and there is a wealth of advertising material which the visitor or prospective traveller will find most useful in planning his tour. As the publisher states, this book is a "must" for anyone travelling in the northwest.

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Science and the Future of Man

Edited by Robert L. Carovillano and James W. Skenhan. 1971. M.I.T. Press, Cambridge, Massachusetts. 196 pp. $10.

The value of this book lies in the merit of its authors, who are a highly qualified group of men involved with environmental questions; the scope of their interests and careers gives the reader an excellent opportunity to compare the thinking of people from diversified backgrounds. Together they question science's present and future impact on man and nature. The book arises from a symposium jointly sponsored by Boston College and the American Association for the Advancement of Science, and is organized into three sections.

The first section encompasses science and the problems of society. The first speaker and the only Canadian, Tuzo Wilson, deals with the stagnation of scientific thought which is a product of the archaic educational system found in universities. He suggests a better future would be found in less, rather than in more, specialization. Victor Yannacone is a lawyer who sees the major battles for environmental quality as taking place in the courtrooms. He points an accusing finger at the law, which allows the exploitation of irreplaceable resources, but believes that through legislation we can replace and improve the offending laws. Paul Parks is a city engineer but does not have an engineer's love for technology. Technology has only complicated our lives and he urges us to simplify our existence before pollution has a chance to destroy us. As a chemist, Donald Horning believes that although science has not created a safe world for us, it is still

worth salvaging. Science must be directed away from narrowly defined research toward more sweeping problems in order to act as a guide in law-making.

The second section raises questions on the place of the scientist in society. Franklin Long leads the discussion by urging both scientist and layman to recognize the scientist not as a super-being but as a citizen who must make a contribution to society. John Platt suggests "What We Must Do" by calling for a huge effort by scientists to concentrate their time not on space program research but on issues that are presently overwhelming in the shortness of time left to solve them. George Wald, the only biologist to speak, is the most philosophical. Life has meant different things to each generation but never have we had as much lethal knowledge. He does not doubt that life is in trouble and thinks now is the time for man to regain mastery over the cause, technology. As a professor of physics at M.I.T., Victor Weisskopf is very familiar with technological processes. He believes that if we are to understand science we must first understand nature. Lewis Mumford finds that many scientists still do not take responsibility for their activities. Few are the intellectually and emotionally integrated men in science who are able to evaluate their research of, or its effects on, the future of mankind.

The last section of the book is simply called "Confrontation," and Robert Drenan, an educator and congressman, calls us to re-evaluate priorities which we give to science. Senator Muskie is notable as a politician for his personal concern for the environment. He would like an environmental consciousness to be built into decision-making on all levels of society.

Lastly, remarks are made on the preceding discussions by Philip Abelson, editor of *Science*, and Erwin Canham, editor of the *The Christian Science Monitor*.

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Bedford Institute of Oceanography: Biennial Review 1971/72

Dartmouth, Nova Scotia. 366 pp.

This year the now familiar Biennial Review is of particular interest for two reasons: it marks the 10th anniversary of the founding of the Bedford Institute of Oceanography; and it is the first issue since the massive reorganizations of several divisions of the Canadian Federal Civil Service into the new Department of the Environment. From the Bedford viewpoint the most significant feature of this regrouping was the transfer of a major part of the Marine Sciences Branch to the Institute, resulting in the formation of the Atlantic Geoscience Centre early in 1972.

The bulletin opens with a series of essays which in themselves form a representative microcosm of the present major marine interests of Canada: advances in marine pollution research, the interaction between fisheries management and environmental concerns, global tectonics, and the great resurgence of interest in our main waterway, the St. Lawrence. The balance of the Review deals with the activities of the three laboratories of the Institute, the Atlantic Oceanography Laboratory (AOL), the Marine Ecology Laboratory (MEL), and the new Atlantic Geoscience Centre (AGC).

The AOL program report reflects the major switch during the 1960s to serious consideration and study of the multiple influences of man on the oceanic environment. This drive has been stepped up during the 1970s, yet without sacrificing efforts to achieve basic understanding of all phases of ocean dynamics.

The report of MEL activities is equally wide-ranging and comprehensive. While the number of personnel concerned with aspects of environmental quality has grown significantly during the last few years, the basic aim of the MEL remains the same. This is to develop and extend knowledge of the dependence of fisheries resources and their food chains on both short- and long-term changes and fluctuations in the marine environment. During the existence of MEL a major effort has been directed towards interpretation of the dynamics of the intensive production of the Gulf of St. Lawrence and the coastal shelf of eastern and southeastern Nova Scotia. In the Gulf, fish production has been found to relate to the rate of river outflow. Perhaps two-thirds of the variation in catches has been attributed to changes in suitability of the environment for survival of fish larvae. This survival rate is, of course, reflected in the commercial fisheries some years later when the fishable recruits enter the fishery.

The MEL studies are accumulating evidence to show that events in the eastern Canadian coastal zone have important influences on production in important fisheries areas. Eventually Bedford may be able to establish a system of year-class strength predictions for some fisheries, as is done for the North Sea herring fishery in England. The MEL has also begun to take an

active interest in aquacultural research aspects in the last few years. An intensive environmental quality research program has to date concentrated on oil pollution, chlorinated hydrocarbon residues, and heavy metals such as mercury. Personnel at the MEL have been interested in the movement of organochlorine compounds and heavy metals through food chains in the sea. While it is well known that this occurs, the actual dynamics and chemical mechanisms were, until recently, almost completely unknown.

The formation of the AGC appears to have gone reasonably smoothly, with minimum interruption of established programs, while the new administration formulated short-term and long-term goals. Immediate concern focuses on a national program of energy and mineral resource evaluation, and the need to provide the nation with the information and expertise required for the rational utilization and exploitation of non-living resources of the Canadian marine environment. Here again, short-term necessities of national need have to be balanced against longer-term aims. Ultimately the AGC plans to produce and document a complete geological description of the structure, history, and composition of the eastern Canadian offshore region.

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NEW TITLES

Zoology

***Alaska fishing guide.** By editors of Alaska Magazine. 1974. Alaska Northwest Publishing Company, Anchorage, Alaska. 176 pp. $3.95 + .50 postage.

Animal reproduction. By P. Street. 1974. David and Charles, Devon, England. £4.25.

★***Animals of Manitoba.** Edited by R. E. Wrigley. 1974. Manitoba Museum of Man and Nature, Winnipeg. 158 pp. $2.50.

Animals of the dark. By C. Roots. 1974. David and Charles, Devon, England. £3.50.

Animals that frighten people. Fact versus myth. 1973. By D. E. Shuttlesworth. Dutton, New York. 122 pp. $4.95.

Animal traps and trapping. By J. A. Bateman. 1974. David and Charles, Devon, England. £3.50.

The biology of Protozoa. By M. A. Sleigh. 1973. Elsevier, New York. 316 pp. $25.50.

Bird migrations. Ecological and physiological factors. Edited by B. E. Bykhovskii. 1971. Translated from the Russian by E. D. Gordon. Halsted (Wiley), New York, and Israel Program for Scientific Translations, Jerusalem. 1974. 298 pp. $31.50.

The buzzard. By C. Tubbs. 1974. David and Charles, Devon, England. £3.75.

The cheetah. By R. L. Eaton. 1974. Van Nostrand Reinhold, New York. 178 pp. $12.95.

Confessions of a bird watcher. By R. Barton. 1974. McGraw-Hill, New York. 236 pp. $7.95.

Deer management. Improved herds for greater profit. By J. de Nahlik. 1974. David and Charles, Devon, England. £3.25.

***The ecology of stray dogs.** A study of free-ranging urban animals. By A. M. Beck. 1973. York Press, Baltimore. 98 pp. $9.50.

A field guide to the insects of Britain and northern Europe. By M. Chinery. 1974. Houghton Mifflin, Boston. 352 pp. $9.95.

Fishes of the world. A key to families and a checklist. By G. U. Lindberg. 1971. Translated from the Russia by H. Hardin. Halsted (Wiley), New York, and Israel Program for Scientific Translations, Jerusalem, 1974. 546 pp. $42.50.

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***Illustrated keys to the freshwater fishes of Alaska.** By J. E. Morrow. 1974. Alaska Northwest Publishing Company, Anchorage, Alaska. 80 pp. $2.95 + .50 postage.

Insects in relation to plant disease. By W. Carter. 1973. Wiley-Interscience, New York. 2nd edition. 760 pp. $39.50.

Interrelationships of fishes. Papers from a symposium, London, England, June 1972. Edited by P. H. Greenwood, R. S. Miles, and C. Patterson. 1974. New York. 536 pp. $31.

Introduction to the primates. Living and fossil. By S. I. Rosen. 1974. Prentice-Hall, Englewood Cliffs, New Jersey. 246 pp. $8.50.

★***The moths of America north of Mexico.** Fasc. 20, 2, Bombycoidea (Saturniidae). 1971–72. E. W. Classey Ltd., Hampton, Middlesex, England. 277 pp. 2 parts. $78.00.

Ocean wanderers. A natural history of migratory sea birds. By R. M. Lockley. 1974. David and Charles, Devon, England. £4.50.

★***Ontario nest records scheme.** Tenth report. 1956–1973. By G. K. Peck. 1973. Royal Ontario Museum and Canadian Wildlife Service. 27 pp.

Paleobiology of the invertebrates. Data retrieval from the fossil record. By P. Tasch. 1973. Wiley, New York. 946 pp. $19.95.

Perspectives in ethology. By P. P. G. Bateson and P. H. Klopfer. 1974. Plenum Press, New York. 336 pp. $17.50.

★**A phylogenetic tree of the animal kingdom.** Including orders and higher categories. By J. Kukalova-Peck. 1973. National Museums of Canada, Ottawa. 78 pp. $5.75.

The physiology of Insecta. Vol. 3. Edited by M. Rockstein. 1974. Academic Press, New York. 518 pp. $38.

Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico. By T. P. Rebel. 1974. University of Miami Press, Coral Gables, Florida. 2nd edition. 250 pp. $10.

Wild horses and asses. By I. Montagu. 1974. David and Charles, Devon, England. £3.50.

Botany

Alaskan arctic tundra. Proceedings of a symposium, Barrow, Alaska, Aug. 1972. Edited by M. E. Briton. 1973. Arctic Institute of North America, Washington, D. C. 224 pp. Cloth $10, paper $7.50.

***Genetics of forest ecosystems.** By K. Stern and L. Roche. 1974. Springer-Verlag, New York. 330 pp. $29.60.

★***Géographie floristique du Québec-Labrador.** Distribution des principales espèces vasculaires. By C. Rousseau. 1974. Les Presses de l'université Laval, Québec. 799 pp. $30.00.

Leguminosae of the United States. I. Subfamily Mimosoideae. By D. Isely. 1973. New York Botanical Garden, Bronx, New York. 152 pp. $7.

Mycology guidebook. Edited by R. B. Stevens. 1974. University of Washington Press, Seattle. 704 pp. $15.

***Peatlands.** By P. D. Moore and D. J. Bellamy. 1973. Springer-Verlag, New York. 221 pp. $12.

Plants. A scanning electron microscope survey. By J. H. Troughton and F. B. Sampson. 1974. Wiley, New York. 158 pp. $8.50.

The vanishing lichens. By D. Richardson. 1974. David and Charles, Devon, England. £3.50

Environment

Air pollution technology. By D. E. Painter. 1974. Reston Publishing (Prentice-Hall), Reston, Va. 284 pp. $13.95.

★**Alberta Environment Conservation Authority.** 1973. Third Annual Report. 9912 – 107th Street, Edmonton, Alberta. 199 pp. This volume reports upon the tasks assigned to the Authority, gives a general statement on the environment in relation to the province, and reports on its work during the year.

***Battle for the wilderness.** By M. Frome. 1974. Praeger Publishers, New York and Washington. 246 pp. $10.25.

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